MYCOLOGIA

VOL. VI MAY, 1914 No. 3

OBSERVATIONS ON SPHAEROSOMA AND ALLIED GENERA

FRED. J. SEAVER

(WITH PLATE 123, CONTAINING 10 FIGURES)

In response to a paper recently published on the genus *Lamprospora*,[1] the writer has received from Doctor Roland Thaxter a very interesting plant which it was suggested might belong to that genus, or, possibly, to the genus *Boudiera*. Examination of the spores and paraphyses of this plant, which was collected at Kittery Point, Maine, led the writer to suspect that it was very closely related to *Sphaerosoma echinulatum* of the writer.[2] In fact the spores and paraphyses scarcely differed from those of my own plant. A later examination of the entire plant showed considerable difference in the gross characters of the two, the Maine plant resembling in general appearance a *Lamprospora* rather than a *Sphaerosoma*. In spite of this fact, however, there was sufficient similarity between the two to suggest that they were, at least, very closely related.

The study of this plant has suggested a review of the facts regarding the identity of the genus *Sphaerosoma* and its relation to other genera of the discomycetes. Several papers have recently appeared on this subject, but there are still a number of points which are not entirely clear. Many of these questions will never be cleared up until the species of *Sphaerosoma* are collected in sufficient quantity to make a careful morphological study of the

[1] MYCOLOGIA **6**: 5–24. *pl. 114*. 1914.

[2] Jour. Myc. **11**: 2–6. *pl. 75*. 1905.

[MYCOLOGIA for March, 1914 (**6**: 49–102), was issued March 18, 1914].

genus and its relation to other genera. In the meantime, mycologists will continue to speculate on the probable relationship of *Sphaerosoma* to other genera, as best they can, with the limited knowledge based of the scant material which is available.

The genus *Sphaerosoma* was founded by Klotzsch on *S. fuscescens*. As pointed out by Professor Setchell,[3] there have been various interpretations as to the exact character of the spores of this species, some describing them as echinulate, others as reticulate, and still others as verrucose. Professor Setchell in assuming that the spores in *Sphaerosoma fuscescens* were echinulate has suggested that this type of plant be regarded as the true *Sphaerosoma* and has followed Hennings[4] in treating the reticulate-spored species in the separate genus *Ruhlandiella*. In describing his Californian species, it was therefore placed in the genus *Ruhlandiella* since the spores were reticulate.

The writer has recently examined a specimen of *Sphaerosoma fuscescens* collected in Germany by Klotzsch. While this specimen is not actually marked type, we have reason to believe that it is a part of the type collection. At least, it is probably as authentic as any material that can be had. The spores of this plant are deeply areolate or reticulate, the ridges of the areolae extending two or three microns beyond the periphery of the spore and often appearing as short spines. The spore characters of this plant are very similar to those of *Ruhlandiella hesperia* Setchell, a specimen of the type of this latter species having been examined by the writer through the kindness of Professor Setchell. From the nature of the spores, it is not difficult to account for the description of the spores as both reticulate and echinulate.

It is not even difficult to understand how the spores might have been described as verrucose when we recall that most of the reticulate-spored discomycetes were originally described with verrucose spores. *Peziza Crouani* was so described by Phillips and *Peziza aurantia* has been repeatedly described and illustrated with verrucose spores, although both species have spores which are distinctly reticulate. Even with the microscopes used at the present time, it is often difficult to make out the exact nature of the

[3] Univ. Calif. Pub. **4**: 107–118. *pl. 15*. 1910.
[4] Hedwigia **42**: (*22*). 1903.

spore markings in some of these species, and they may even be interpreted differently by different observers. It is possible, however, as suggested by Professor Setchell that Corda[5] had the wrong plant.

Whatever view we accept with reference to Corda's illustration and the accompanying description, the fact remains that Klotzsch's plant examined by the writer shows the spores to be reticulate, and I am therefore compelled to agree with Roupert[6] as to the character of the spores in *Sphaerosoma fuscescens* Klotzsch. Professor Setchell's plant would then according to this view be a true *Sphaerosoma* and rather closely related to the type species.

The suggestion that the Maine plant might be a *Boudiera* and possibly *B. areolata* Cooke & Phill.[7] together with the fact that this eastern plant was found to have spores almost identical with my own *Sphaerosoma echinulatum* from Iowa, has prompted a more thorough investigation of the character of the European *Boudiera areolata.* Fortunately, I have been able to examine a specimen of this species collected in North Wales and which is apparently a part of the type. To my surprise I find that the mature spores of this species are strongly echinulate and so far as I am able to judge identical with Thaxter's plant and my own, although it is possible that the areolae are a little less distinct in the Iowa plant than in the other two. In the original description of *Sphaerosoma echinulatum* the following note was appended referring to the spores: "Microscopic examination shows on the surface in addition to the spines markings which resemble reticulations, but these are short and not continuous and are not seen at the periphery of the spore, so that they are probably only spines bent so as to give this appearance." From this it will be seen that the semi-reticulate character of the spores was noted in the Iowa plants, although possibly misinterpreted. The spores of the three plants examined might be described at maturity as echino-reticulate with a strong emphasis on the "echini." The spores in both the Iowa and the European plant, however, show a variety of changes in the course of their development. The very young spore is smooth later becoming slightly roughened, the roughenings in

[5] Corda, Icones Fung. **6**: 52. *pl. 11, f. 100.* 1854.
[6] Bull. Acad. Sci. Cracovie **1909**: 76–95. 1909.
[7] Grevillea **6**: 76. 1877.

the partly matured spore often taking the form of reticulations, the ridges becoming more pronounced about the periphery of the spore until at maturity they appear echinulate with the spines connected by the broken and interrupted ridges mentioned above. The intermediate forms were not seen in the Maine plant for lack of material. All at maturity are pale yellowish-brown.

From the above observations it is evident that we have three plants with spores which are, so far as I am able to determine, identical, *i. e., Boudiera areolata* Cooke & Phill., *Sphaerosoma echinulatum* of the writer and the unnamed plant collected by Dr. Thaxter in Maine. From the gross characters, however, I would not suspect that Dr. Thaxter's plant is the same as my own. The plants in the former are smaller, subturbinate, with the hymenium convex and asci strongly protruding. In the latter the plants are larger, flattened below, with the hymenium forming almost a complete semi-circle and the protruding asci not evident, although it is possible that this latter character might have been overlooked in the Iowa plants. When we take into consideration the fact that only five plants were collected in Maine and several hundred in Iowa, it is possible that these apparent differences in gross characters might fade out if the eastern plant could be collected in larger quantity.

Dr. Thaxter's plants accord more closely with early illustrations of *Boudiera areolata* Cooke & Phill. than do my own. However, after studying part of the type of *B. areolata* the writer is convinced that *Sphaerosoma echinulatum* is only an American form of *Boudiera areolata* of European authors. That this is a European species is evident from the fact that the species has been collected twice in Europe since its description from Iowa material, but each time it has been referred to the name given to the American plant with no suggestion that it had been previously described in Europe. The illustration of *Boudiera areolata* by Boudier[8] fits *Sphaerosoma echinulatum* so far as gross characters and color are concerned. The section, however, shows the hymenium as occupying the upper surface only and in this it does not agree with the *S. echinulatum*. This sketch, however, may be diagrammatic.

The habitats of three collections also show a striking similarity. The European plant was originally collected by William Phillips

[8] Boudier, Ic. Myc. *pl. 417.* 1909.

in North Wales and was said to grow on moist ground on the margin of a lake. The habitat of the Maine plant was given by the collector as follows: "It was growing on bare clay mud, where cattle had stamped around a small pond which dries up in midsummer." Dr. Thaxter states that although the original locality has been visited many times since the original collection was made, no more of the plants could be found. My own plants were collected in a pasture at the foot of two small ravines in a depression which is wet a good part of the year. Here cattle had tramped about until the ground was very uneven with standing water in the low places. The plants grew on the bare clayey soil about the margin and on the elevated portions which were very wet. The type locality has been visited only once since the original collection was made in 1904. The latter visit was during the summer of 1912. A special search was made for the plant at this time. The season did not appear to be favorable, but a few immature plants were found, so that I have reason to believe that the species occurs in that locality regularly when the conditions are favorable. At the time of the original collection, two other discomycetes were found growing in company with it, *Ascobolus viridis* and *Lamprospora Crec'hqueraultii*. Both of these plants were found to be present at the time of the last visit.

The genus *Boudiera* was founded by Cooke on *Boudiera areolata*. The genus was placed in the Ascobolaceae apparently on account of the protruding asci, a character which was thought to be restricted to the Ascobolaceae, and in fact one of the characters on which the family is segregated. This character is common to a number of the Pezizaceae, including members of the genus *Lamprospora*, as has been previously noted. The fact that *Boudiera* is often described as having violet spores and is made to include plants of a coprophilous habitat is likely to be misleading, since the type species shows neither of these characters.

If the genus *Boudiera* as represented by the type species is to be retained as a separate genus, it must be regarded as a close relative of *Lamprospora* on the one hand and as showing at least a superficial resemblance to *Sphaerosoma* on the other. Whether this superficial resemblance is an indication of close natural relationship remains to be seen. This resemblance was noted by

Cooke[9] when he stated in referring to *Boudiera,* "in some respects allied also to *Sphaerosoma.*"

Several of the points raised in the present paper are purposely left open with the hope that additional material collected in the field will help to settle some of the questions which are here only suggested.

CONCLUSIONS

The spores of *Sphaerosoma fuscescens* Klotzsch, type of the genus *Sphaerosoma,* are reticulate and not echinulate as concluded by Professor Setchell. *Ruhlandiella hesperia* Setchell is then a true *Sphaerosoma* and closely resembles the type species.

Sphaerosoma echinulatum Seaver is a plant closely resembling *Boudiera areolata* Cooke & Phill. and is probably only an American form of that species and not a true *Sphaerosoma* at all.

Boudiera as represented by *B. areolata* is a genus closely allied to *Lamprospora* on the one hand and showing at least a superficial resemblance to *Sphaerosoma* on the other, a fact which was noted by Cooke, the author of the genus. Whether this resemblance is any indication of natural relationship is a question.

The unnamed plant collected by Dr. Thaxter in Maine, although showing some differences in gross characters, closely resembles in microscopic details *Sphaerosoma echinulatum* of the writer and both are, so far as I can determine, identical in spore characters with *Boudiera areolata* of European authors. Whether the apparent differences in gross characters are of specific importance can be determined only by the collection and study of more abundant field material.

EXPLANATION OF PLATE CXXIII

Spores and paraphyses drawn with the aid of the camera lucida to a common scale and with the same combination of lenses used in drawings of *Lamprospora* spores, MYCOLOGIA **6**: *pl. 114.*

1–4. *Boudiera* sp. from plant collected by Thaxter in Maine, 1, plant about natural size; 2, plant × 7; 3–4, ascus with spores and paraphysis × 450.

5–6. *Boudiera areolata* Cooke & Phill.; 5, partially matured spore; 6, ascus with mature spores × 450. Drawn from material collected in North Wales and apparently a part of the type.

7–10. *Sphaerosoma echinolatum* Seaver; 7, young spore; 8, partially matured spore; 9 and 10, ascus with spores and paraphysis × 450. Drawn from type.

[9] Grevillea **7**: 57. 1878.

NORTH AMERICAN SPECIES OF PERIDERMIUM ON PINE[1]

JOSEPH CHARLES ARTHUR AND FRANK DUNN KERN

Nearly eight years ago the writers published an article in the *Bulletin of the Torrey Botanical Club*[2] treating of the species of *Peridermium* then known in North America. Since that time much information has accumulated to supplement what was there said and to correct some errors. That article was founded upon meager material for the most part, but all then available, yet it served an important purpose in stimulating observation and in directing attention to the less known forms.

It is now proposed to review that portion of the previous article which related to the forms of *Peridermium* occurring upon the leaves and bark of various species of pine, and to leave the remainder of the article for possible future notice. In thus restricting the work it will be feasible to show some advances that have been made in the last eight years, to discuss the difficulties encountered in limitation and identification of species, and to set forth the more conspicuous problems for the future. To do this much for the pine-inhabiting species will require as much space as can well be granted for a single article, although other genera of gymnospermous hosts bear species of *Peridermium* in equal need of similar presentation.

The first discussion of the American pine-inhabiting forms was by Underwood and Earle[3] in 1896, who ably presented the subject as known at that time. Only three species were recognized from the eastern United States: *Peridermium acicolum* and *P. orientale* both on leaves and *P. cerebrum* on bark. Two species not seen by the authors had been described from western United States: *P. filamentosum* and *P. Harknessii*, both on bark. A species from

[1] Read before the Botanical Society of America, Atlanta meeting, December 31, 1913.

[2] Volume 33, pp. 403–438. 1906.

[3] Underwood, L. M., & Earle, F. S.: Notes on the pine-inhabiting species of *Peridermium*. Bull. Torrey Club **23**: 400–405. 1896.

Colorado, *P. Engelmanni,* was erroneously included among western forms, probably because published as on *Pinus Engelmanni,* now referred to the genus *Picea.*

The five recognized species in 1896 had expanded to fifteen species when the present authors published in 1906, seven being on leaves and eight on bark. At the present time all the seven leaf forms seem to be worthy of recognition, one additional species has been described by Long in the meantime, one species has been introduced from Europe, and two forms are to be separated in this paper, making eleven leaf forms altogether. The greatest upheaval and readjustment has taken place among the bark forms. Much reliance was necessarily placed at first on the form of the gall, but later information derived in part from cultures has given better apprehension of the species. The aecial form of the oak *Cronartium, P. cerebrum,* is now made to include the western form, *P. Harknessii,* as well as the three supposed new species of our former paper, *P. fusiforme, P. globosum,* and *P. mexicanum.* The two diverse-appearing forms, *P. filamentosum* and *P. stalactiforme,* have been united with some hesitation. The misuse of the name, *P. pyriforme,* has been rectified, and the aecial form of the currant rust, *P. Strobi,* which has been introduced from Europe since our former paper, has been added. Altogether five species of bark forms are recognized, the same as previously, but differently assorted.

So far as known, fourteen species out of the sixteen included in this paper are native to North America, and of the fourteen only two are also known outside of North America. One of these, *P. Rostrupi,* is common in Europe, and the other, *P. cerebrum,* is common in Japan.

The remaining two species have been introduced from Europe in recent years, and neither of them is yet established. One of them, *P. Strobi,* is of such economic interest that a stubborn fight is being waged against it in this country. The other one, *P. Fischeri,* is only known in one tree nursery in Wisconsin, and was first seen in 1912. It was found on *Pinus sylvestris,* being the first collection of a *Peridermium* on the leaves of this conifer to be found in North America. In the North American Flora (vol. 7, page 94) *P. oblongisporium,* which also occurs on *Pinus*

sylvestris, is mentioned. The occasion of the citation was the appearance of the alternate stage on *Senecio vulgaris* in Rhode Island. But the rust did not become established, and has not been reported since. The aecial form has never been seen in this country.

The three main sources of information which have led to a better understanding of the forms of *Peridermium* on pine are increased collections with field observations, culture work, and microscopic comparison.

The collections in herbaria are remarkably few and imperfect, due doubtless to two main reasons. These forms of rust appear early in the season when not many collectors of rusts are in the field, and consequently even when abundant they are only incidentally represented in sets of specimens. The bark forms for the most part produce large galls, sometimes a foot or more in diameter, and almost invariably cumbrous and troublesome in comparison with most rust specimens. In consequence only a small fragment of the original gall as a rule is taken, and often with scant data. Specimens in the best condition to study must generally be placed in boxes, as fruits and woody fungi are, rather than in mycological packets. Field observations relative to the probable alternate forms are meagre and principally by a few observers in recent years.

Culture work is not so simple and expeditious as with most other groups of rusts. The information obtained in this way is invaluable, and it will never be possible to have definite knowledge of the species until many more cultures are made, than are at present available. Up to the present writing the following is the record of cultures made in North America with the several forms of *Peridermium* on pine, both foliicolous and caulicolous.

Cultures in the field may result in valuable information, and can afterward be substantiated under glass, if necessary. Damp cool weather is most favorable for the work. Sowings from teliosporic material of *Coleosporium* may be made by suspending fresh material over growing pines, more conveniently over low or seedling pines, care being taken that such material does not wilt for some hours, and that the pine leaves have a moist surface, at least during one night. In the case of *Cronartium* the germinat-

RECORD OF THE CULTURES PROVING RELATIONSHIPS BETWEEN THE SPECIES OF PERIDERMIUM AND THEIR ALTERNATE PHASES

Year	Species of *Peridermium* Host of Culture Material	Trial Host Species of *Cronartium* or *Coleosporium*	Investigator Place of Publication
1902	*Per. cerebrum* *Pinus virginiana*	*Quercus coccinea* *Cron. Quercus*	Shear, Jour. Myc. **12**: 89–92. 1906.
1904	*Per. Rostrupi* *Pinus rigida*	*Campanula americana* *Col. Campanulae*	Kellerman, Jour. Myc. **11**: 32. 1905.
1906	*Per. acicolum* *Pinus rigida*	*Solidago rugosa* *Col. Solidaginis*	Clinton, Rep. Conn. Exp. Sta. for **1906**: 320. 1907.
1907	*Per. cerebrum* *Pinus virginiana*	*Quercus velutina* *Cron. Quercus*	Arthur, Jour. Myc. **13**: 194. 1907.
1907	*Per. Comptoniae* (*"pyriforme"*) *Pinus sylvestris*	*Comptonia asplenifolia* *Cron. Comptoniae*	Clinton, Rep. Conn. Exp. Sta. for **1097**: 380–383. 1908.
1910	*Per. carneum* *Pinus Taeda*	*Vernonia crinita* *Col. Vernoniae*	Arthur, Mycologia **4**: 29. 1912.
1912	*Per. filamentosum* (*"stalactiforme"*) *Pinus contorta*	*Castilleja miniata* *Cron. coleosporioides*	Meinecke; Hedgcock, Phytopath. **2**: 176. 1912 (further details in letter from Meinecke); also Meinecke, Phytopath. **3**: 167. 1913.
1912	*Per. filamentosum* *Pinus* [*scopulorum*]	*Castilleja* sp. *Cron. coleosporioides* (*"filamentosum"*)	Hedgcock, Phytopath. **2**: 176–7. 1912.
1912	*Per. Comptoniae* *Pinus sylvestris, P. ponderosa*	*Comptonia asplenifolia* *Cron. Comptoniae*	Spaulding, Phytopath. **3**: 62. 1913.
1913	*Per. cerebrum* (*"fusiforme"*) *Pinus Taeda*	*Quercus rubra, Q. Phellos* *Cron. Quercus*	Arthur & Kern, here reported.
1913	*Per. inconspicuum* *Pinus virginiana*	*Coreopsis verticillata* *Col. inconspicuum*	Hedgcock and Long, Phytopath. **3**: 250. 1913.
1913	*Per. delicatulum* *Pinus rigida*	*Euthamia graminifolia* *Col. delicatulum*	Hedgcock and Long, Phytopath. **3**: 250. 1913.
1913	*Per. Comptoniae* *Pinus ponderosa*	*Comptonia asplenifolia* *Cron. Comptoniae*	Hedgcock; Spaulding in Phytopath. **3**: 308. 1913.
1913	*Per. Comptoniae* *Pinus ponderosa, P. sylvestris, P. Taeda, P. austriaca*	*Comptonia asplenifolia* *Cron. Comptoniae*	Spaulding, Phytopath. **3**: 308, 309. 1913.

ing teliospores are inserted into a slit in the bark of the pine, care being taken to include as little debris as possible and to keep the surface moist for some hours.

The basidiospores both in *Coleosporium* and *Cronartium* are ready to be shed immediately upon maturity of the telia, which is largely from July to late fall. The earlier maturing telia are likely to give best results. Some indications of success may occasionally be seen after a few weeks, but the aecia are not likely to appear until the following spring.

Reverse cultures may similarly be made by suspending leaves or bark of pine, bearing the aecia, over the suspected alternate host, usually low growing herbs. Such work must largely be done in spring; and the first mature aecia from such cultures may be again used, and provide more viable spores than those gathered in the field. The uredinia that result from aecial infection will probably appear within ten to thirty days, usually on the under side of the leaves.

Herbarium specimens should invariably be saved, both of the material from which sowings are made, and of the resulting spore forms.

In the present stage of knowledge there is needed a large amount of work on the microscopic characters of the collections now in herbaria. It not infrequently happens that two collections having similar gross appearance present well marked microscopic differences. Or it may be that two specimens with dissimilar gross appearance, as *P. cerebrum* and *P. fusiforme,* now known to be one species, have no material microscopic differences, when well studied. A certain amount of variation in all the microscopic characters must be expected, in some species more than in others. The extent of this variation in each species can only be ascertained by extended microscopic study of large numbers of authenticated collections made at different times and places. Although more characters are now utilized than formerly, especially those pertaining to the peridium, and better technique employed, yet it is not likely that all species can be definitely separated by microscopic characters alone. Especially among those species of *Peridermium* which are aecial forms of *Coleosporium,* that is, the foliicolous forms, there is frequently great similarity. But even

in such cases, careful microscopic diagnoses must be held important.

KEY TO THE FOLIICOLOUS SPECIES OF PERIDERMIUM ON PINUS, ALL BEING THE AECIAL STAGE OF SPECIES OF COLEOSPORIUM

Peridia low, fragile, and inconspicuous.
- Peridial cells quadrilateral in face view, 20–29 μ long. — 1. *P. delicatulum.*
- Peridial cells oblong in face view, 38–55 μ long. — 2. *P. inconspicuum.*

Peridia medium-sized, mostly 0.5–1.2 mm. high.
- Peridial cells slightly overlapping, the side walls 3–4 μ thick or less.
  - Spores broadly ellipsoid, the wall 2 μ or less thick. — 3. *P. Fischeri.*
  - Spores narrowly oblong, the wall 2 μ or more thick. — 4. *P. montanum.*
- Peridial cells strongly overlapping, the side walls 5–9 μ thick.
  - Spores moderately and uniformly verrucose, the wall uniformly thick. — 5. *P. californicum.*
  - Spores closely verrucose, sometimes with a smooth area, the wall varying in thickness. — 6. *P. acicolum.*

Peridia large and firm, mostly 0.7–1.5 mm. high, occasionally up to 2.5 mm.
- Peridial cells rather finely verrucose, spores verrucose with large deciduous papillae. — 7. *P. gracile.*
- Peridial cells rather coarsely verrucose.
  - Peridial cells with side walls moderately thick (4–7 μ).
    - Spores evenly and moderately verrucose. — 8. *P. intermedium.*
    - Spores densely verrucose with prominent elongate papillae. — 9. *P. Rostrupi.*
  - Peridial cells with side walls very thick (7–12 μ).
    - Spores with walls moderately thick (2.5–3.5 μ). — 10. *P. guatemalense.*
    - Spores with walls thick (3.5–5.5 μ). — 11. *P. carneum.*

1. PERIDERMIUM DELICATULUM Arth. & Kern, Bull. Torrey Club 33: 412. 1906

O. Pycnia 0.3–0.4 mm. broad by 0.5–1 mm. long, low-conoidal, 80–100 μ high.

I. Aecia erumpent from longitudinal slits 1–5 mm. long, delicate, scarcely protruding above the ruptured epidermis; peridial cells usually quadrilateral or hexagonal in face view, 16–24 x 20–29 μ, not or only slightly overlapping, the side walls 2–3 μ thick, the inner wall finely and closely verrucose with uniform papillae;

aeciospores ovoid or cuboidal, 19–21 x 21–28 μ, the wall 1.5–2 μ, finely and evenly verrucose.

On *Pinus rigida* Mill., Connecticut (*Clinton*), Maryland (*Hedgcock & Long,* see Mycologia **4**: 282. 1912), Massachusetts (*E. T. Bartholomew* in Barth. N. Am. Ured. *720*).

On *Pinus* sp., Florida (Holway in Barth. N. Am. Ured. *517*).

Type collected at St. Augustine, Florida, on *Pinus* sp. (doubtfully *P. Taeda*) March 27, 1903, *E. W. D. Holway.*

DISTRIBUTION: Atlantic coast from Massachusetts to Florida. The telial collections range from Maine to Kansas southward to West Virginia and Texas, but have not been found in the southeastern part of the United States.

This species stands apart from the other foliicolous species on pine on account of the short, fragile peridium and the small, quadrilateral peridial cells. *Per. inconspicuum,* since described by Long, has a peridium which resembles this species in being rather short and delicate, but differs in having larger, thicker-walled peridial cells of an oblong shape. The range for the species has been extended northward along the Atlantic coast as far as Massachusetts, but when careful search is made for it, the range will doubtless be found much greater.

Clinton (Rep. Conn. Exp. Sta. for 1912, p. 353) made observations in the field which led him to think that the telial stage of this form occurs on *Euthamia,* and recently confirmatory cultures have been reported by Hedgcock and Long (Phytopath. **3**: 250. 1913). The species apparently has distinctive microscopic characters, and is to be called *Coleosporium delicatulum* (Arth. & Kern) Hedg. & Long, Phytopath. *l. c.*

2. PERIDERMIUM INCONSPICUUM Long, Mycologia **4**: 283. 1912

O. Pycnia 0.2–0.3 mm. broad by 0.3–0.7 mm. long, low-conoidal, 85–120 μ high.

I. Aecia flattened laterally, 0.3–0.7 mm. long, by 0.3–0.8 mm. high; peridial cells oblong in face view, 19–27 x 38–55 μ, overlapping, the side walls 3–4 μ thick, the inner wall rather finely and closely verrucose with uniform papillae; aeciospores ellipsoid, 16–18 x 22–30 μ, the wall 1.5–2 μ, finely and very closely verrucose.

On *Pinus virginiana* Mill., Maryland (*Charles; Long,* June 16, 1912).

Type collected at Glen Echo, Maryland, on *Pinus virginiana*, May 5, 1907, *Miss V. K. Charles.*

DISTRIBUTION: Atlantic coast in vicinity of type locality. The telial stage is known only from about the same region.

The species resembles *Per. delicatulum* somewhat in gross appearance and in the microscopic anatomy of the spores, but differs, as pointed out in a foregoing paragraph, in the character of the peridial cells. The alternate stage has been established by cultures reported by Hedgcock and Long (Phytopath. **3**: 250. 1913), and occurs on *Coreopsis*. At present it is known on *C. verticillata* and *C. major*. It is now separated from *Coleosporium Helianthi*, with which it was included in the North American Flora (**7**: 93 1907), under the name *Coleosporium inconspicuum* (Long) Hedg. & Long.

3. PERIDERMIUM FISCHERI Kleb., Zeitschr. Pf.-Kr. **5**: 71. 1895

O. Pycnia not seen.

I. Aecia flattened laterally, 0.5–1.5 mm. long, 0.5 mm. high; peridial cells in face view broadly ellipsoid, slightly overlapping, the inner wall finely verrucose, the outer wall merely punctate; aeciospores broadly ellipsoid, more or less angular, 18–25 x 25–32 μ, the wall thin, up to 2 μ, closely and moderately verrucose.

On *Pinus sylvestris* L., "Evergreen Nursery," Sturgeon Bay, Wisconsin (*Davis*, June 25, 1913).

Type collected in Europe. (The type collection has not been seen, and the data in hand do not enable us to give details.)

In December, 1912, Dr. J. J. Davis transmitted to the junior author a specimen of *Coleosporium* from J. G. Sanders, which was collected by him in a nursery at Sturgeon Bay, Wis., on Sept. 19, 1912. This proved to be *Coleosporium Sonchi-arvensis* (Pers.) Lev., on *Sonchus asper*, and the first collection of the rust for North America.

In June, 1913, Dr. Davis visited the locality where the *Coleosporium* occurred and found aecia "in profusion on *Pinus sylvestris*," as he wrote in a letter. Material of this collection has been carefully studied, and although it does not agree exactly with the descriptions given by European students, it is here listed, and with some confidence, as no other collection on the leaves of the

Scotch pine has been reported from North America, and as this one was found where telia of the species had been collected. Two other scanty collections were made in the vicinity both on pine seedlings, thought to be *Pinus Banksiana,* which resemble the *Peridermium* on *Pinus sylvestris,* but they are not included for want of sufficient collateral evidence. The history of this discovery is related by Dr. Davis in a recent number of Phytopathology (**3**: 306. Dec., 1913).

4. PERIDERMIUM MONTANUM Arth. & Kern, Bull. Torrey Club **33**: 413. 1906

O. Pycnia 0.3–0.5 mm. broad by 0.5–1 mm. long, low-conoidal, 55–65 μ high.

I. Aecia flattened laterally, 1–1.5 mm. long by 0.5–1 mm. high; peridial cells ovoid to ellipsoid in face view, 23–35 × 45–65 μ, often acutish at one or both ends, slightly overlapping and easily separating, the side walls 3–4 μ thick, the inner wall rather finely verrucose with low papillae of irregular outline; aeciospores oblong to linear-oblong, 16–24 × 32–45 μ, the wall 2–3 μ, closely and rather coarsely verrucose.

On *Pinus Murrayana* Oreg. Com., Montana (*Blankinship, Stuart*); Washington (*Suksdorf 302 & 645*); Alberta (*Holway*); Rocky Mountains, Canada? (*Macoun*).

On *Pinus scopulorum* (Engelm.) Lemm., Montana (*Kelsey*).

Type collected at Rimini, Montana, on *Pinus scopulorum,* June 24, 1889, *F. D. Kelsey.*

DISTRIBUTION: The far northwest, from central Montana westward and northward.

The standing of this species remains unchanged, since its publication. One or two observers have reported finding *Coleosporium Solidaginis* in close proximity to it and have suggested a possible relation but since the specimens referred here differ very materially in microscopic characters from *Per. acicolum* of the eastern states, which is now known to belong to *Coleosporium Solidaginis,* the species is still maintained. A more likely connection would be with *Coleosporium arnicale,* which may possibly occur on more than one species of *Arnica* from the region indicated above.

5. **Peridermium californicum** sp. nov.

O. Pycnia 0.4–0.7 mm. broad by 0.5–1 mm. long, low-conoidal, about 90 μ high.

I. Aecia tongue-shape, 0.7–1.5 mm. long by 0.8–1.2 mm. high; peridial cells ellipsoid in face view, usually rounded at both ends, overlapping, 29–35 x 50–87 μ, the side walls 5–7 μ thick, the inner walls rather coarsely and closely verrucose with slightly irregular papillae; aeciospores broadly ellipsoid, 25–29 x 40–45 μ, the wall 3–4.5 μ, moderately and rather coarsely verrucose.

On *Pinus radiata* Don. (*P. insignis* Dougl.), California (*Holway*).

Type collected at Monterey, California, on *Pinus radiata*, February, 1908, *E. W. D. Holway*.

DISTRIBUTION: Known only from the type locality on the coast of middle California.

The collection here described as a new species has been made, as the date will indicate, since the publication of our first paper. It was at first determined as *Per. montanum* but a more careful study reveals the fact that it differs very markedly in the peridial cells. In this species the peridial cells are longer, thicker-walled, more coarsely verrucose, and more overlapping than in *Per. montanum*. These distinctive morphological characters together with the fact that there are several unattached species of *Coleosporium* in the region where the collection was made seem to be sufficient to warrant its recognition as a new species.

6. PERIDERMIUM ACICOLUM Underw. & Earle, Bull. Torrey Club **23**: 400. 1896

O. Pycnia 0.3–0.5 mm. broad by 0.5–0.8 mm. long, low-conoidal, 80–100 μ high.

I. Aecia flattened laterally, 0.5–1 mm. long by 0.6–1.2 mm. high; peridial cells ellipsoid to ovoid in face view, 23–27 x 40–70 μ, overlapping, the side walls 5–9 μ thick, very coarsely and prominently verrucose with closely set papillae of varying size; aeciospores ellipsoid or obovoid, 20–24 x 28–40 μ, the wall closely and coarsely verrucose, with prominent, somewhat deciduous tubercles, sometimes with a smooth spot extending up one side, varying in thickness from 3–4 μ below up to 5–6 μ in the upper part.

On *Pinus pungens* Mill., Pennsylvania (Charter Oak, June 2, 1913, *Orton & Adams*).

On *Pinus rigida* Mill., Connecticut (*Bishop; Clinton,* S. Manchester, June 6, 1906, used for successful cultures on *Solidago* by the collector; *Thom*); Delaware (*Jackson,* Seaford, June 4, 1908); Pennsylvania (*Buckhout; Orton & Adams*); Massachusetts (*E. T. Bartholomew* in Barth. N. Am. Ured. *710; Cummings & Seymour* in Seym. & Earle, Econ., Fungi *223; Underwood 2862*); New Jersey (*Pennypacker* in Ellis & Ev. N. Am. Fungi *2222, Shear*); New York (*Sirrine; Whetzel & Reddick,* Junius Swamps, May 25, 1906, *Reddick,* same locality, June 1, 1907; North Carolina (*Marr*).

Type collected at Sudbury, Massachusetts, on *Pinus rigida,* June 7, 1891, *L. M. Underwood 2862.*

DISTRIBUTION: From Massachusetts and central New York southward to central North Carolina. The telial stage is known on *Solidago Aster,* and allied genera, almost throughout North America, and eventually aecial collections are likely to be taken over a far greater range than here indicated.

The most interesting development in connection with this species is the proof of its relationship to *Coleosporium Solidaginis* furnished by Clinton's cultures. This seems to be the only folicolous species where the spores show any tendency to a smooth area after the style of the caulicolous species. This feature is not always discernable and was probably over-emphasized in our previous description. The range is here extended to western New York and southward into North Carolina.

The repeating spores of the sporophytic stage enable the species to maintain itself in regions where pines do not occur, as they often are either produced or remain viable throughout the winter, and start infection in spring without intervention of aecia.

7. PERIDERMIUM GRACILE Arth. & Kern, Bull. Torrey Club 33: 417. 1906

O. Pycnia 190–350 μ broad by 0.5–0.75 mm. long, low-conoidal, 60–75 μ high.

I. Aecia flattened laterally, 0.5–1.5 mm. long by 1–1.8 mm. high; peridial cells broadly ellipsoid in face view, 23–29 × 30–45 μ, overlapping, the side walls 4–5 μ thick, the inner wall rather finely and closely verrucose with uniform papillae; aeciospores ellipsoid, 18–

24 x 23–39 μ, the wall 3–3.5 μ thick, closely and evenly verrucose with large deciduous tubercles.

On *Pinus filifolia* Lindley, Oaxaca (*Pringle*); Jalisco (collector unknown).

Type collected in the mountains above Oaxaca, Mexico, on *Pinus filifolia,* May 28, 1894, *C. G. Pringle.*

DISTRIBUTION: Central Mexico; only two collections known.

There is no additional information concerning this species. The name was an unfortunate selection as there was a *Peridermium gracile* of Harkness (Bull. Calif. Acad. Sci. **1**: 36. 1884) on *Sarcobatus* which has been shown by cultures to be the aecial stage of a grass rust (*Puccinia subnitens*).

8. PERIDERMIUM INTERMEDIUM Arth. & Kern, Bull. Torrey Club **33**: 416. 1906

O. Pycnia 0.3–0.4 mm. broad by 0.5–0.75 mm. long, low-conoidal, 65–80 μ high.

I. Aecia tongue-shaped, 1.5–3 mm. long by 0.8–1.5 mm. high; peridial cells broadly ellipsoid, 19–34 x 34–50 μ, overlapping, the side walls 4–7 μ thick, the inner wall rather coarsely and closely verrucose with somewhat irregular tubercles; aeciospores ellipsoid, 16–20 x 23–29 μ, the wall 2.5–3.5 μ, evenly and moderately verrucose.

On *Pinus echinata* Mill. (*P. mitis* Michx.), Arkansas (*von Schrenk*); Maryland (*Galloway*); Missouri (*Barlow 1573, Demetrio* in Rab.-Wint. Fungi Eur. *3315a*); North Carolina (*Howe, von Schrenk*).

Type collected at Perryville, Missouri, on *Pinus mitis,* May, 1883, by *C. H. Demetrio* (Rab.-Wint. Fungi Eur. *3315a*).

DISTRIBUTION: From central Missouri and Arkansas to central North Carolina.

No further data concerning the standing or telial connection of this species have come to our attention, and it is here retained in its original form. The North Carolina localities are new.

9. PERIDERMIUM ROSTRUPI Ed. Fischer, Bull. Soc. Bot. France **41**: clxxii. 1894

O. Pycnia 0.2–0.4 mm. broad by 1–2 mm. long, low-conoidal, 90–110 μ high.

I. Aecia tongue-shaped, 1–3 mm. long by 0.7–1.5 mm. high; peridial cells ellipsoid in face view, 19–30 x 35–58 μ, overlapping, the side walls 4–6 μ thick, the inner wall rather coarsely verrucose with slightly irregular and somewhat deciduous tubercles; aeciospores broadly ellipsoid or globoid, 17–22 x 22–31 μ, the wall 2–3.5 μ thick, densely verrucose with prominent elongate papillae.

On *Pinus rigida* Mill., Ohio (*Kellerman,* Sugar Grove, May 17, 1902, May 1902 in Ohio Fungi *104,* May 1903, May 30, 1904; *Werner,* Ironton, May 27, 1892); Maryland (*Norman*); New Jersey (*Martindale,* in the previous paper this specimen was erroneously listed under *Per. acicolum*); North Carolina (*von Schrenk*).

Type collected in Europe, but the original publication gives no details concerning the host, place, date, or collector's name.

DISTRIBUTION: From New Jersey and central Indiana southward to central North Carolina; also in Europe. The telial stage is known over a slightly wider range.

As stated in the previous paper culture work has been done both in Europe and North America showing the relation of this species to *Coleosporium Campanulae.* No additional work has been reported since our last paper.

10. **Peridermium guatemalense** sp. nov.

O. Pycnia 0.4–0.7 mm. broad by 0.5–1.5 mm. long, low-conoidal, 51–77 μ high.

I. Aecia flattened laterally, 1.5–4 mm. long by 1–1.5 mm. high; peridial cells ellipsoid to globoid in face view, 23–26 x 26–71 μ, overlapping, the side walls 8–10 μ thick, the inner wall moderately verrucose with somewhat irregular papillae; aeciospores ellipsoid, 19–23 x 29–35 μ, the wall 2.5–3.5 μ thick, rather coarsely verrucose with irregular tubercles.

On *Pinus filifolia* Lindley, Guatemala (*Kellerman*).

Type collected at Antigua, Depart. Sacatepequez, on *Pinus filifolia,* Feb. 13, 1905, *W. A. Kellerman 4626.*

DISTRIBUTION: Known only from the type locality in central Guatemala.

When the material first came into our hands we were inclined to call it *Per. gracile;* it was even listed in a paper on The Rusts of Guatemala (Kern, Jour. Myc. **13**: 23. 1907) as that species.

The peridial cells, however, have side walls about twice as thick as in that species, and the markings are coarser and more irregular. Inasmuch as there are a number of species of *Coleosporium* in Central America which call for the existence of *Peridermiums*, the separation of this form is made with considerable confidence.

11. PERIDERMIUM CARNEUM (Bosc) Seym. & Earle, Econ. Fungi *550*. 1899

Tubercularia carnea Bosc, Ges. Nat. Freunde Berlin Mag. **5**: 88. 1811.

Peridermium oblongisporium Ravenellii Thüm. Mitth. Forstl. Vers. Oest. **2**: 316 (20). 1880.

Peridermium Ravenelii Kleb. Ber. Deutsch. Bot. Ges. 8^2: 69. 1890.

Aecidium Ravenelii Diet. in Engler & Prantl, Pflanzenfam. 1^{1**}: 78. 1897.

Aecidium carneum Farl. Bibl. Index **1**: 25. 1905.

O. Pycnia 0.4–0.7 mm. broad by 1–1.5 mm. long, low-conoidal, 60–80 μ high.

I. Aecia flattened laterally, large, 1–6 mm. long by 1–2.5 mm. high; peridial cells broadly ellipsoid in face view, 21–39 by 38–61 μ, overlapping, the side walls 7–12 μ thick, the inner wall coarsely and rather closely verrucose with uniform papillae; aeciospores ellipsoid, 21–29 x 26–35 μ, the wall 3.5–5.5 μ thick, closely verrucose with rather large tubercles often appearing deciduous.

On *Pinus Elliotii* Engelm., Florida (*Tracy,* as on "*P. australis*"); Georgia (*O'Gara*); Mississippi (*Earle,* as on "*P. australis*"; *Tracy,* as on "*P. heterophylla*").

On *Pinus palustris* Mill. (*P. australis* Michx.), Florida (*Rolfs; Stevens; Swingle* in Barth. Fungi Columb. *3043*), Louisiana (*Hedgcock,* Forest Path. no. *344*).

On *Pinus Taeda* L., Alabama (*Arthur, Kern* & *Lloyd; Atkinson,* as on "*P. serotina*"; *Underwood* & *Earle*); *Florida* (*Burger; Burger* & *Fawcett; Fawcett; Martin,* Green Cove Springs, Crescent City in Ellis, N. Am. Fungi *1026b,* both as on "*P. australis*"; *Rau* in Rab.-Wint. Fungi Eur. *3315b,* as on "*P. australis*"; *Sturgis* in Seym. & Earle, Econ. Fungi *550* as on "*P. palustris*"; *Underwood*); Georgia (*Ravenel* in Ellis N. Am. Fungi

1026a; Underwood, Toccoa, April 19, 20, and 21, the last in Seym. & Earle, Econ. Fungi *224*); Mississippi (*Arthur* & *Stretch*); Texas (*Hedgcock,* Forest Path. no. *708*).

Type collected in South Carolina on *Pinus palustris.*

DISTRIBUTION: From central North Carolina to Florida and westward to central Texas. The telial stage on *Vernonia* is common and abundant from the Gulf of Mexico to Massachusetts, Indiana and Kansas, considerably further northward than the aecial stage has been seen.

Since the previous paper several cultures have been made which show the genetic relation between this species and *Coleosporium Vernoniae.* The first cultures were made by the senior writer in the spring of 1910 (see preceding table) with *Peridermium* specimens sent from Florida; supplementing cultures were made the following season with material collected in Mississippi (see Mycologia **4**: 57. 1912); and still further cultures with Florida material were made in 1913. The range of the species has been extended northward from South Carolina into North Carolina and southwestward from Mississippi into Texas.

There are several other species of *Coleosporium* common in this range and some of them have been suspected of belonging to aecial forms very much like *Per. carneum* but no positive cultures have ever been made proving such relationships. It may be possible, however, that some of the specimens here listed may be shown later to belong elsewhere. There is a considerable variation in the size and thickness of walls of the spores in these specimens but since in the experimental work both extremes have been cultured on *Vernonia* the present disposition seems the only one at present possible.

KEY TO THE CAULICOLOUS SPECIES OF PERIDERIUM ON PINUS, ALL BEING THE AECIAL STAGE OF SPECIES OF CRONARTIUM

Branch or stem not noticeably swollen, peridia more or less cylindrical, not confluent.	12. *P. filamentosum.*
Branch or stem with slight fusiform enlargement, peridia subhemispherical, rounded or irregular, sometimes confluent.	
Spores pyriform, finely and closely verrucose.	13. *P. pyriforme.*
Spores ellipsoid or obovate.	
Spores with wall 1.5–2.5 μ thick, moderately verrucose with uniform papillae.	14. *P. Strobi.*

Spores with wall 2.5–4 μ thick, coarsely verrucose with irregular papillae.	15. *P. Comptoniae.*
Branch or stem gradually or abruptly swollen into a gall, peridia more or less tortuous, usually confluent.	16. *P. cerebrum.*

12. PERIDERMIUM FILAMENTOSUM Peck, Bot. Gaz. **7**: 56. 1882

Aecidium filamentosum Farl. Bibl. Index **1**: 44. 1905.

Peridermium stalactiforme Arth. & Kern, Bull. Torrey Club **33**: 419. 1906.

O. Pycnia unknown.

I. Aecia chiefly on branches 6–12 mm. in diameter, not producing noticeable swellings, scattered, solitary, cylindrical or subcompressed, 1–2 mm. in diameter, usually elongated, sometimes up to 6 or 7 mm. high; peridium rupturing laterally, with more or less evident filament-like processes passing through the spore-mass from apex to base of sorus, or when on *Pinus contorta* and its close allies often appearing on larger branches, the sori often irregular, shorter and more nearly hemispherical, the processes extending from the apex and floor of the aecium only a short distance into the spore-mass; aeciospores oblong, obovate-oblong, or ellipsoid, 14–24 x 23–35 μ; wall 2.5–4 μ thick, closely and rather coarsely verrucose, some spores showing a smooth area on one side toward the base.

On *Pinus ponderosa* Dougl., Arizona (*Pringle*).

On *Pinus scopulorum* (Engelm.) Lemm., Colorado (Monte Vista, 1907, *Hedgcock*, as on "*P. ponderosa*"; near Mancos, June 6, 1911, *Phillips*, Timber & Forest Dis. Sur. no. *9085*, as on "*P. ponderosa*"; Allen's Park, July 5, 1911, *Spangler;* Devil's Head Mountain, *Dakin;* Pikes Peak, June, 1912, *Notestein*, as on "*P. ponderosa*," used for successful cultures on *Castilleja* by *Hedgcock*, see Phytopath. **2**: 176. 1912).

On *Pinus contorta* Dougl., California (*Long*), Oregon (*Meinecke*, Fort Klamath, May 23, 1912, used for successful cultures on *Castilleja* by the collector).

On *Pinus Jeffreyi* Oreg. Com., Nevada (*Baker 1351*).

On *Pinus Murrayana* Oreg. Com., Washington (*Suksdorf 645*, type of *P. stalactiforme*).

Type collected in Arizona, "on living branches of *Pinus ponderosa*, July, *Pringle*" (the type specimen in the N. Y. State Mu-

seum which we have seen, bears the additional data, Santa Rita Mts., July 13, 1881, *Pringle* no. *32*).

DISTRIBUTION: The Rocky mountains from their eastern limits in Colorado to the eastern slopes of the Coast Range, and north and south from the Canadian to the Mexican boundaries. The telial stage on *Castilleja* is now known from nearly the same range.

This rust, as here represented, consists of two forms somewhat unlike in gross characters and hosts, but agreeing well in microscopical characters and apparently in telial relations. The form listed above on *Pinus ponderosa* is the one on which Peck's name *filamentosum* was based. This form is especially characterized by elongated cylindrical sori and by the presence of longitudinal filaments within the peridium. The specimens on *Pinus scopulorum,* a close ally of *P. ponderosa,* while not possessed of the typical characters in so striking a manner as the original seem to belong here. The fact that none of these specimens seem typical may be due to their state of preservation, all of them being considerably weathered, whereas the original specimen on *P. ponderosa* was collected and preserved in prime condition. It was with one of these semi-typical forms that Hedgcock reports successful cultures on *Castilleja.*

The form on *Pinus contorta* and its two close allies agrees in making noticeable swellings of the branches and in microscopical characters but it differs in having shorter, more nearly hemispherical sori, which are sometimes irregular in outline. It is with material of this sort that Meinecke reports cultures on *Castilleja.* The apparent difference between this *Peridermium* and the one used by Hedgcock in his cultures on *Castilleja* has led the latter to assume (Phytopath. **2**: 176–7) that two entirely independent species exist. Our examination of a number of specimens of *Cronartium* on *Castilleja* in both uredinial and telial stages from all parts of the geographical range has failed to indicate any morphological variations and this has led us to the opinion that we may possibly be dealing with two *Peridermium* races, with certain structural differences, which have the same telial connection. We have, therefore, ventured to place the *Pinus contorta* forms, to which the name *Per. stalactiforme* belongs, under *Per. filamentosum* although it is done with some doubt. Further cul-

tures are needed before any final conclusion can be reached. We are indebted to Messrs. Hedgcock and Meinecke for furnishing for our studies portions of their authentic material.

The structural differences between these two forms, which are partly one of length of the peridium, may not be so essential as might appear at first thought. Ordinary aecia, which usually appear short and cupulate, oftentimes have been known to grow out into a cylindrical shape many times as long as broad. The presence of the distinct filaments seems very remarkable in Peck's type and has never been duplicated in any specimens examined by us although the attenuate projections from floor and dome of the aecium as previously pointed out under *Per. stalactiforme* are homologous. It may be possible that none of the specimens listed under this species, except the type, should be referred to *Per. filamentosum* and that this name should be retained for specimens which bear its characters in an unmistakable manner. An argument against such a disposition, however, is the fact that there is no known species of *Cronartium* which might be a telial connection, in other words, if we keep these two forms separate we have more forms of *Peridermium* than are required to account for the known telial stages.

13. PERIDERMIUM PYRIFORME Peck, Bull. Torrey Club **6**: 13. 1875

Aecidium pyriforme Peck, Farl. Bibl. Index **1**: 78. 1905.
Peridermium Betheli Hedg. & Long, Phytopath. **3**: 251. 1913.

O. Pycnia unknown.

I. Aecia appearing on the branches or often on the trunks, with no or only slight fusiform enlargements, scattered and usually distinct, oval or irregular in outline, sometimes elongate, 1–3 by 1–6 mm. or larger by becoming confluent, peridium not much exserted above the roughened bark, rupturing along the sides and falling away; aeciospores pyriform, oblong-pyriform, or obovate, 19–24 x 32–66 μ, usually acuminate below; wall 2–3 μ thick, rather finely and closely verrucose with low papillae; contents orange-yellow when fresh.

On *Pinus Banksiana* Lamb. (*P. divaricata* Auct.), Wisconsin (Douglas County, July 1907, *Davis*).

On *Pinus Murrayana* Oreg. Com., Colorado (Gatos, July 23,

1906, three miles north of Allen's Park, June 21, 1913, *Bethel*); Alberta (Devil's Lake, Banff, July 5, 1907, *Holway*).

On *Pinus ponderosa* Dougl., British Columbia (*Vernon*, May, 1913, *Brittain*, communicated by *Fraser*).

On *Pinus pungens* Lamb., Pennsylvania (Charter Oak, June 2, 1913, *Orton* & *Adams*).

On *Pinus scopulorum* (Engelm.) Lemm., Colorado (three miles north of Allen's Park, June 21, 1913, *Bethel;* South Dakota (Rockerville, June 1909, *White*).

On *Pinus* spp., New Jersey (Newfield, *Ellis 2040*); Washington (Seattle, 1906, *Bonser 65*).

The type specimen in the State Museum, Albany, N. Y., is labeled "on pine limbs in the spring, Newfield, New Jersey, *J. B. Ellis*, no. *2040*." In the original publication it states that Mr. Ellis says that the specimen may have been collected in Georgia and placed by accident among the New Jersey specimens, but it is in the original wrapper and there is strong circumstantial evidence that the inscription on the type specimen is correct.

DISTRIBUTION: New Jersey to Colorado and Washington, northward into western Canada. The probable telial stage on *Comandra* has a slightly wider range, extending into eastern Canada, and into California.

The study of some fresh specimens which have very recently (summer, 1913), come into our hands, together with some data accumulated since our previous paper, has resulted in a complete change of opinion regarding the standing of this species, *Per. pyriforme*. In his original description Peck laid emphasis on the form of the spores which he described as "obovate, pyriform, or oblong-pyriform, acuminate below, .0015–.0025 inch long." We had seen the type specimen, which consists of a portion of a branch a little more than a centimetre in diameter and about 4 cm. long, but we had no opportunity to make a microscopic examination of the spores. Never having seen a *Peridermium* with spores such as Peck described, it was only natural that we should assume that there was something wrong about Peck's description. Knowing that peridial cells are sometimes pyriform we came to the conclusion that he probably mistook some of the smaller peridial cells

for spores. With this for an explanation it was possible for us to make his name *pyriforme* apply to a similar looking species common in that range which had ordinary, small, ellipsoid spores. The species to which we made his name apply was the one which has since been culturally connected with *Cronartium Comptoniae*.

Recently when a fresh specimen, collected in British Columbia and communicated to us by W. P. Fraser, with an apparent abundance of spores dropping off in heaps of orange-yellow powder, was examined, we were surprised to find in the first mount only large pyriform bodies. An attempt to regard them as peridial cells not only seemed futile from the first, but was soon rendered impossible by the finding of unmistakable peridial tissue composed of very different cells. An undetermined specimen on a branch of *Pinus Banksiana* collected in Wisconsin in 1907 by J. J. Davis was next thought of. This is an old weathered specimen without any visible sign of peridia but it was remembered that an examination had showed pyriform cells very like the fresh ones then being studied. In both these specimens these pyriform cells had a low verrucose sculpturing very unlike peridial cells, and since their shape and size agreed precisely with Peck's original description the belief that we were dealing here with a characteristic and practically unknown species, except for the obscure type, was gradually forced upon us. Fortunately within a few days some fresh specimens received from Colorado collected by E. Bethel added to our supply of this striking species. These developments gave impetus to the study and we next turned to the herbarium to see if any specimens belonging here might have been placed erroneously, and carelessly, in some other species. Our suspicions were well founded, and we were soon able to add South Dakota, Washington, and Alberta to our list of localities. We were soon able to secure spores from the type specimen in the Museum at Albany, N. Y., which abundantly confirmed Peck's original description, and our recent inferences.

The next problem to present itself was very naturally the question of an alternate phase. According to our new conception we had a *Peridermium* species distributed across the continent from New Jersey to British Columbia with enough intermediate localities to make the distribution continuous throughout the range.

The deduction was soon made that *Cronartium Comandrae* is the probable connection, inasmuch as it is an unassociated form with nearly an identical geographical distribution, *i. e.*, northern United States and southern Canada from ocean to ocean. The fact that it is the only unattached *Cronartium* now known would be enough to strongly suggest the relation, but the complete coincidence of range is a prominent factor in support of the theory. A further bit of evidence is furnished by the field observations of E. W. D. Holway who stated on the packet of his Alberta collection that it was undoubtedly associated with a *Cronartium* on *Comandra*.

Collectors in the eastern states, especially, should be on the lookout for this interesting species. Although apparently very meagerly represented in herbaria from this region it doubtless occurs not infrequently, judging from the numerous collections of the *Cronartium* on *Comandra*.

14. PERIDERMIUM STROBI Kleb. Abh. Nat. Ver. Bremen **10**: 153. 1887

O. Pycnia scattered, honey-yellow, forming minute bladdery swellings; pycniospores hyaline, ovoid or elliptical, 2–4 μ across.

I. Aecia on fusiform swellings of the stem or branches, usually scattered and solitary, rounded or somewhat elongate, 1–1.5 by 2–5 mm., subhemispherical, 1–2 mm. high, rupturing irregularly along the sides; aeciospores broadly ellipsoid or obovoid, 18–24 x 22–27 μ; wall 1.5–2.5 μ thick, moderately verrucose with low uniform papillae, with a smooth area apparent on some spores at the base often extending up one side.

On *Pinus Strobus* L. Introduced from Europe, through nursery stock, into the northeastern Unitel States and Indiana, Ohio, and Ontario, Canada, in 1909 according to Spaulding, Bull. Bur. Pl. Ind. no. 206, 1911.

Type collected in Bürgerpark, Bremen, Germany, on the bark of *Pinus Strobus*. It was first observed in 1886 but the information in the original publication is not definite enough to permit the designation of any particular collection as type.

DISTRIBUTION: Locally introduced with nursery stock from Maryland and Vermont to Illinois and Wisconsin, but believed to have been destroyed in every case; common in Europe.

The rust here described under the name *Per. Strobi* is the one

which has come to be generally known as "the blister rust of white pine," and has been connected by numerous cultures in Europe and America with the *Cronartium* on *Ribes*. The presence of the aecial stage (*Per. Strobi*) in North America has been known only since 1909 when it was imported in nursery stock from Germany and widely distributed, especially in the northeastern states. The rust on the *Ribes* has been known for a somewhat longer period. The first record was a collection of the uredinial stage on *Ribes longiflorum* (reported as *R. aureum*) in Kansas in 1892. Definite observations on a sufficient scale to indicate its establishment in this country date back only to 1906 when Stewart found the uredinial stage in the currant plantation of the Experiment Station at Geneva, N. Y. Since that time it has been reported in various localities. There is no information at hand which is of assistance in explaining the early isolated occurrence in Kansas. Through Mr. W. H. Rankin, of Cornell, we learn that recently (spring, 1913), two white pine trees, about fifteen years old, have been found at Geneva with evidence of old infection of the blister rust.[4] One tree is said to show signs of having been infected when very young and long cankers, almost girdling the trunk, have spread upward from the lower whorl of branches, where infection took place, a distance of about three feet. The fungus was fruiting in abundance this spring (1913) on the newly invaded tissue at the edge of the cankers. The fact that this must have been fruiting several years ago will assist in accounting for the original epidemic at Geneva, as well as for more recent outbreaks there.

The condition which obtains in North America with regard to this species is a peculiar one. The white pine, a native only of this continent, was not originally afflicted with a rust disease but upon being extensively grown from seeds in European nurseries it became subject to this extremely damaging species which was later imported to its native country by nursery stock. It is so serious in some parts of Europe that the culture of the white pine has had to be abandoned. The same condition will doubtless be reached

[4] This is mentioned by Spaulding, Phytopath. 4: 4 (1914) in an abstract of a paper entitled "Notes on the white pine blister rust," and also by Stewart and Rankin, Phytopath. 4: 5. 1914.

in this country if every precaution is not taken to stamp out the disease. Recently the rust has been found fully established on large trees of native white pine in northern Vermont. Steps have been taken to extirpate it in this locality. The quarantine regulations of the various states and of the federal government are clearly efforts in the right direction. It may be found necessary eventually to prohibit importation of white pine stock.

Since 1909, and possibly earlier, the presence of a *Cronartium* on *Ribes longiflorum* has been known from Colorado through the collections of Mr. E. Bethel. The rust has been especially common in the parks of Denver and Boulder, and has appeared each year in the same spots since the first observation, but does not seem to have spread. Search at different times by Mr. Bethel has failed to reveal any aecial source of the infection. No white pines, or other species of pine which could be suspected of harboring the rust, grow in the immediate vicinity. A careful search was made at the Boulder station in August, 1911, by the writers aided by Mr. Bethel, and again in August, 1912, by the senior writer alone, but no additional evidence could be detected to explain the outbreak.

15. PERIDERMIUM COMPTONIAE (Arthur) Orton & Adams, Phytopath. **4**: 24. 1914

Cronartium Comptoniae Arth. Bull. Torrey Club **33**: 29. 1906.
Peridermium pyriforme [Peck, misapplied by] Arth. & Kern, Bull. Torrey Club **33**: 419. 1906.

O. Pycnia unknown.

I. Aecia chiefly on small branches 0.5–2 cm. in diameter, or on the trunks of small trees 2.5–5 cm. in diameter, producing only slight fusiform enlargements, individual sori rounded or irregular, 1–1.5 by 1–2 mm. across, sometimes larger by becoming confluent, subhemispherical, 1–2 mm. high, rupturing irregularly along the sides; aeciospores ellipsoid or obovate, 16–24 x 24–33 μ; wall 2.5–4 μ thick, rather coarsely verrucose with irregular and somewhat deciduous tubercles, with a smooth area at base often extending up one side.

On *Pinus austriaca* Höss., Connecticut (*Clinton*, see Rep. Conn. Exp. Sta. for 1912, p. 354).

On *Pinus echinata* Mill., North Carolina (*Spaulding,* see Phytopath. 3: 309. 1913); Pennsylvania (Bear Meadows, Center County, May 26, 1913, communicated by *C. R. Orton*).

On *Pinus maritima* Poir, Connecticut (*Clinton,* see Rep. Conn. Exp. Sta. for 1912, p. 354).

On *Pinus montana* Mill., Connecticut (*Clinton,* see Rep. Conn. Exp. Sta. for 1912, p. 354).

On *Pinus ponderosa* Dougl. (cultivated), Massachusetts (Arnold Arboretum, May 28, 1884, specimen in Herb. Farlow); Wisconsin (Trout Lake, June 28, 1913, *Moody,* communicated by *A. G. Johnson*).

On *Pinus rigida* Mill., Connecticut (Storrs, June 4, July 5, 1907, *Thom*); New Jersey (Newfield, May, 1890, *Ellis*); New York (Albany, June 8, 1910, Hudson Falls, June 22, 1911, *Atwood*).

On *Pinus sylvestris* L., Connecticut (Rainbow, Experiment Station forest, June 15, 1907, *Clinton,* used for successful cultures on *Comptonia* by the collector); Missouri (fruticetum Missouri Botanical Garden, St. Louis, May 1887, *Pammel*); New York (Albany, May 19, 1911, in shipment of trees from Massachusetts, *Atwood,* in nursery at Bluff Point, near Plattsburgh, May, 1912, communicated by *Rankin*).

On *Pinus Taeda* L., New Jersey (*Spaulding,* see Phytopath. 3: 309. 1913).

On *Pinus virginiana* Mill (*P. inops* Ait.), New Jersey (*Ellis* in N. Am. Fungi *1021*).

DISTRIBUTION: Massachusetts to North Carolina westward to the Mississippi river from Wisconsin to Missouri, but chiefly eastward.

The species here represented is the one to which we misapplied the name *pyriforme* in our previous paper. In gross appearance it resembles somewhat the genuine *pyriforme* although it is usually on the smaller branches or stems while the latter is more often on larger limbs or trunks. In general appearance and in the habit of attacking the stems of seedlings and small trees this species is perhaps more closely allied to the white pine rust. It differs from that species very materially in microscopic spore characters, having larger, thicker-walled spores, which are verrucose with coarse, irregular, deciduous tubercles, rather than with uniform, permanent tubercles.

In several instances our attention has been called to the damage which this species is doing to seedlings of the Scotch pine in nurseries. The general similarity in appearance and habit has led some observers to suggest that perhaps the Scotch pine and white pine blister rusts might be the same species. In this connection the morphological differences above pointed out are of interest, but of still greater importance is the fact that Clinton has succeeded in culturing the Scotch pine rust on *Comptonia asplenifolia*. The relationship of the pitch pine specimens here listed to *Cronartium Comptoniae* is also unquestionable. With the data obtained from field observations, morphological characters, and infection experiments it seems that we are safe in concluding that the pitch and Scotch pine rusts are the same species and quite distinct from the white pine species.

More recently (June, 1913), specimens have come to hand showing that this species is also causing damage to *Pinus ponderosa* in a nursery in northern Wisconsin. Since the *Cronartium* on *Comptonia* has been collected in the same region the outbreak may be explained. With the exception of this locality and one in the fruticetum of the Missouri Botanical Garden, where an infected tree was doubtless planted, the species seems to be pretty well confined to the eastern United States.

Recently (Phytopath. **3**: 308. Dec. 1913) Spaulding has given an account of the injury which this species of rust has been observed to do among cultivated pines.

16. PERIDERMIUM CEREBRUM Peck, Bull. Buffalo Soc. Nat. Sci. **1**: 68. 1873

Peridermium Harknessii Moore, Bull. Calif. Acad. Sci. **1**: 37. 1884.

Aecidium deformans Mayr, Waldungen Nordam. 119. 1890.

Aecidium giganteum Mayr, Waldungen Nordam. 120. 1890.—Bot. Centr. **58**: 149. 1894.

Peridermium deformans Tubeuf, Pflanzenkr. 429. 1895.

Peridermium giganteum Tubeuf, Pflanzenkr. 429. 1895.

Aecidium cerebrum Dietel, in Engler & Prantl, Pflanzenfam. 1^{1**}: 79. 1897.

Aecidium Harknessii Dietel, in Engler & Prantl, Pflanzenfam. 1^{1**}: 79. 1897.

Peridermium fusiforme Arth. & Kern, Bull. Torrey Club **33**: 421. 1906.

Peridermium mexicanum Arth. & Kern, Bull. Torrey Club **33**: 422. 1906.

Peridermium globosum Arth. & Kern, Bull. Torrey Club **33**: 424. 1906.

O. Pycnia indefinitely spread out over the surface of swellings similar to those on which the aecia appear, the overlying cortical tissues with a rather even surface, 40–50 μ high; pycniospores very numerous, globose, 1.5–2 μ.

I. Aecia appearing on globoid swellings 5–25 cm. across, or on fusiform swellings 2–6 cm. by 5–30 cm. long, usually encircling the comparatively small branches, often causing swollen areas only partially encircling the larger branches or main trunks, individual sori elongate or tortuous, sometimes distinct but often confluent so as to appear cerebroid; peridia circumscissile, soon falling away, sometimes in flakes or sheets; aeciospores obovate or ellipsoid, 15–24 x 23–33 μ; wall 2.5–4 μ thick, rather coarsely verrucose, with a smooth area at base often extending up one side.

On *Pinus contorta* Dougl., Alaska (*Trelease 667*).

On *Pinus Banksiana* Lamb. (*P. divaricata* Auct.), Connecticut (communicated by *Clinton*); Michigan (*Wheeler*); Wisconsin (Lone Rock, May 31, 1890, *Goff*, erroneously listed in former paper, Bull. Torrey Club **33**: 424, as on "*Pinus Strobus*," same locality, May 29, 1912, *Davis*).

On *Pinus echinata* Mill. (*P. mitis* Michx.), Arkansas (*Bethel, von Schrenk*).

On *Pinus radiata* Don. (*P. insignis* Dougl.), California (*Blasdale, Fawcett, Bethel*).

On *Pinus Murrayana* Oreg. Com., California (Yosemite Valley, May 29, 1895, *Blasdale*); Colorado (Bald Mt., Central City, July 4, 1908, Lake Eldora, July 21, 1910, Aug. 5, 1911, June 30, 1912, Silver Plume, Dec. 24, 1906, Tolland, July 30, 1906, Aug. 15, 1906 in Barth, Fungi Columb. *2243*, all by *Bethel;* Tolland, May 18, 1908, *Kern;* Long's Peak Inn, Estes Park, Aug. 7, 1908, *Clements*); Montana (Libbey, Oct. 15, 1911, *Wier 37*); the Colorado and Montana specimens are included here on morphological grounds although some doubt is thrown upon this disposition by the failure up to this time to find the alternate stage within this geographical range.

On *Pinus oöcarpa* Schiede, Jalisco (*Pringle*).

On *Pinus palustris* Mill., Florida (*Rolfs*), Texas (*Spaulding*).

On *Pinus patula* Schiede & Deppe, Hidalgo (*Pringle*).

On *Pinus ponderosa* Dougl.?, British Columbia (Communicated by *Fraser,* 1912), Washington (*von Schrenk*).

On *Pinus rigida* Mill., New Jersey (*Ellis,* in N. Am. Fungi *1022, Shear 1456*); New York (*Lintner*); Ohio (*Kellerman*).

On *Pinus sabiniana* Dougl., California (Colfax, *Harkness 28,* Newcastle, Feb., 1906, *Shear,* Placerville, *Fawcett,* Sept., 1913).

On *Pinus scopulorum* (Engelm.) Lemm., Nebraska (Chadron, Aug. 7, 1909, *Weaver;* Long Pine, May 13, 1896, *Bates 370,* as on "*Pinus ponderosa*").

On *Pinus Taeda* L., Alabama (Auburn, *Earle,* no date, April 1896, *Underwood,* type of *Per. fusiforme* Arth. & Kern, April 6, 1912, *Arthur & Kern,* April 7, *Arthur, Lloyd, & Kern,* March 22 and April, 1913, *Wolf,* the latter two used for successful cultures on *Quercus* by the writers); Florida (Gainesville, Feb. 2, 1906, *Rolfs,* same locality, March 7, 1910, *Burger,* Lake City, Feb. 26, 1909, *Rolfs*); Mississippi (*Tracy*).

On *Pinus virginiana* Mill., Delaware (Seaford, April 24, 1908, *Jackson*); District of Columbia (Washington, May 11, 1903, April 24, 1905, *Shear*); Maryland (Glen Sligo, May 5, 1905, *Ricker;* Takoma Park, May 10, 1906, *Shear,* used for successful cultures on *Quercus* by the senior writer; Takoma Park, April 14, 1907, *Shear;* College Park, Sept. 20, 1910, *Demaree*); North Carolina (Durham, May, 1911, *Wolfe*); Virginia (*Long, Shear*).

On *Pinus* sp., Georgia (*Ravenel, O'Gara*).

Type collected at Centre (now called Karner), New York, on trunks and branches of young pine trees, *Pinus rigida, J. A. Lintner* (the specimen in Herb. Peck bears in addition the date May, but no year is given).

DISTRIBUTION: Nearly throughout the United States, southward to central Mexico; and northward along the mountains to southern Alaska.

This species, as now represented, includes several of the forms which were previously regarded as distinct. The most notable advance in this connection has been the proof by our cultures this season (1913) that the *fusiform* specimens (*Per. fusiforme* A.

& K.), so common in the southern states, have their uredinia and telia on *Quercus*. Perhaps these specimens are sufficiently differentiated so that they might constitute a race but with only the present knowledge of their culture behavior we believe it best simply to include them in the *Cronartium Quercus* species. It is interesting to note that in doing this, after an attempted separation, the pendulum swings back to the original contention of Underwood and Earle (Bull. Torrey Club **23**: 405. 1896), in which they decided that these macroscopic characters should be disregarded, and not be allowed to "serve as specific characters of equal weight with those which require a microscope to detect." They included the fusiform specimens under *Per. cerebrum*. It seems possible that the form of the gall may be dependent to some extent upon the rate of growth taking place in the affected part at the time of infection and for a few months thereafter. The preponderance of the fusiform type of enlargement on *Pinus Taeda* in the south might be due to a more vigorous growth of the host following the infection period than is likely to take place in northern species and localities.

In separating the Wisconsin specimen under the name *Per. globosum* we were influenced to a large extent by supposed identity of the host and to a lesser extent by minor structural characters. The host was given as white pine by a well-known careful collector, but there were no leaves with which to verify the determination. Dr. J. J. Davis has since visited the original locality and finding there only the ordinary *Per. cerebrum* on *Pinus Banksiana* suggested an error with regard to our statement. A portion of the twig was then submitted to Mr. C. T. Humphrey, of the Forest Products Laboratory, University of Wisconsin, who gives it as his opinion that the host cannot be *Pinus Strobus* and that it has all the chief characters of *Pinus Banksiana*. Further microscopic study has also shown us that we laid too much emphasis on the variations noted in the peridial cells. We are, therefore, convinced that the founding of the species was unwarranted. Essentially the same condition holds for *Per. mexicanum* which is also now included under *Per. cerebrum*. With regard to this form we were influenced by slight structural variations and also by the geographical location. The subsequent

knowledge that the *Cronartium* on *Quercus* occurs also in southern Mexico has greatly assisted us in coming to the present conclusion.

Considerable advance has been made also in the knowledge of the development of the aecial stage. With the aid of Dr. C. L. Shear the existence of the pycnial stage has been demonstrated, and a brief technical description has been included in the above diagnosis. Dr. Shear also points out that the fungus seems to have a biennial development, at least he is sure in some cases that only pycnia develop the first season following infection. Two years would thus be required for the development of the aecia.

HOST INDEX TO THE SPECIES OF PERIDERMIUM ON THE SPECIES OF PINUS

australis
carneum 11
austriaca
Comptoniae 15
Banksiana
cerebrum 16
Fischeri 3
pyriforme 13
contorta
cerebrum 16
filamentosum 12
divaricata
cerebrum 16
pyriforme 13
echinata
cerebrum 16
Comptoniae 15
intermedium 8
Elliotii
carneum 11
filifolia
guatemalense 10
gracile 7
"heterophylla"
carneum 11
inops
Comptoniae 15
insignis
californicum 5
cerebrum 16
Jeffreyi
filamentosum 12
maritima
Comptoniae 15
mitis
cerebrum 16
intermedium 8
montana
Comptoniae 15
Murrayana
cerebrum 16
filamentosum 12
montanum 4
pyriforme 13
oöcarpa
cerebrum 16
palustris
carneum 11
cerebrum 16
patula
cerebrum 16
ponderosa
cerebrum 16
Comptoniae 15
filamentosum 12
pyriforme 13
pungens
acicolum 6
pyriforme 13
radiata
californicum 5
cerebrum 16
rigida
acicolum 6
cerebrum 16
Comptoniae 15
delicatulum 1
Rostrupi 9
sabiniana
cerebrum 16
scopulorum
cerebrum 16
filamentosum 12
montanum 4
pyriforme 13
"serotina"
carneum 11
Strobus
Strobi 14
"Strobus"
cerebrum 16
sylvestris
Comptoniae 15
Fischeri 3
Taeda
carneum 11
cerebrum 16
Comptoniae 15
virginiana
cerebrum 16
Comptoniae 15
inconspicuum 2
indet. spp.
cerebrum 16
delicatulum 1
pyriforme 13

INDEX TO SPECIES OF PERIDERMIUM ON PINUS, AND THEIR SYNONYMS

THE DEVELOPMENT OF STROPHARIA AMBIGUA

SANFORD M. ZELLER

(WITH PLATES 124 AND 125, CONTAINING 12 FIGURES)

In the fall of 1911, the writer's attention was called to an agaric which is very conspicuous in fir woods in the vicinity of Seattle, Washington, during the fall and winter months. Specimens have been collected as late as January 17. For this work the very young stages were collected in the fall of 1912. As far as the writer is aware, no study of the development of the genus *Stropharia* has been published and there appears to be doubt about the taxonomy of this particular species.

The earlier literature on the development of the fruiting bodies of the Agaricaceae has been thoroughly reviewed by Atkinson (2), Allen (1), and Beer (3). In 1906, Atkinson found that in the early stages in the development of *Agaricus campestris* there was no differentiation, but a universal veil surrounded the homogeneous mass of hyphae. The first differentiation was the primordium of the hymenium in the form of a deeply stained ring a little above the center of the carpophore and lying some depth under the surface. The gill cavity forms below this hymenium, and the primordium of the pileus is distinguished from that of the stem and marginal veil. Next in the order of development the pileus becomes definitely outlined quite deeply under the surface by taking a deep stain.

In the same year, Allen (1) found the development of *Hypholoma* to be different from that of *Agaricus*. In *Hypholoma* the universal veil is present from the beginning, and the first differentiation is a small central area which stains deeply. This differentiates successively into the primordium of the pileus, hymenium, and upper portion of the stem. The gill cavity is formed internally after the formation of the primordium of the hymenium, and the lamellae are formed by the differential growth of the hyphae of the hymenial primordium.

Three years later, Fischer (4) published his work on the development of *Armillaria mucida,* in which he observes that the hymenial primordium has an endogenous origin, but that the primordium of the pileus precedes the appearance of that of the hymenium.

In 1911, Beer (3) followed with his notes on some species of Agaricaceae. In his work upon *Hypholoma fasciculare,* he practically confirmed what Allen (1) had already reported for *Hypholoma,* while in *Armillaria mellea* he found the sequence of the differentiation of parts and their development to correspond very closely with Atkinson's observations upon *Agaricus campestris.*

During November, 1912, specimens were collected on the campus of the University of Washington. No trouble was experienced in finding all stages from the youngest to the fully developed carpophores. The mycelium in the form of white, silky rhizomorphs was found just under the surface of the decayed organic matter on a moss-covered log of *Alnus oregana.* The rhizomorphs measure about 0.5–1 cm. in diameter. The pure white buttons were easily obtained from the surface of this substratum. Several mature carpophores aided much in locating the tiny button forms, which were readily identified by their viscid upper surfaces. Buttons 1–5 mm. in diameter, and portions of more mature carpophores were fixed in chromo-acetic acid and were carried through alcohol and xylol into paraffin. The sections were generally cut 6 μ thick. In staining, the best results were obtained with acid fuchsin and picric acid, to bring out the early differentiations. The safranin, gentian-violet, and orange combination was used to advantage in older stages. A large number of slides were made and the accompanying plates were photographed from slides chosen from these.

The early stage of the carpophore is an undifferentiated mass of interwoven hyphae which reaches a height of about 1.5 mm. At this time it is about 1 mm. in transverse diameter. Figure 1 shows the earliest stage. Over the surface of this primordial carpophore there is a layer of coarser, more loosely arranged hyphae. This is the universal veil. For the most part, the hyphae of the interior extend vertically from the base where the carpophore is connected with the rhizomorph. Sections of the latter

show it to be made up of a pseudo-parenchymous tissue. In the upper part of the carpophore the hyphae seem to spread and their course is generally parallel with the surface.

The first sign of internal differentiation of the previously homogenous tissue appears in a plane a little above the center of the primordium of the carpophore. Here in medial vertical section two darkly stained patches of descending hyphae appear (Fig. 2). These seem to be the regions of most active growth and are rich in protoplasm. In the remaining sections of the same carpophore these deeply stained areas can be traced as an annular area in the whole carpophore. This is the hymenial primordium. The hyphae of this region are very slender and pointed at first, but eventually they enlarge and become crowded, their lower ends forming an even surface. After this differentiation to form the primordium of the hymenium, an inverted cup-shaped layer of hyphae, rich in protoplasm appears. This extends upward from the outer edge of the hymenial primordium and over the top of the carpophore, remaining the same distance from the surface over the whole area. This forms the primordium of the pileus (Fig. 3). Simultaneously with the differentiation of the pileus the gill cavity is formed by the sagging of the neutral tissue below the hymenial primordium, due to the cessation of growth in that region. Figure 4 shows the primordium of the hymenium enlarged. The primordium of the hymenium increases in width at the outer edge, where the hyphae begin to grow downward and inward as if to form the incurved margin of the pileus. At this stage the partial veil can be distinguished as tissue of lighter stain, extending from the universal veil and the pileus margin to the outer surface of the upper portion of the stem, which is now clearly differentiated (Fig. 5).

Next, a differential growth takes place in the hymenial hyphae. Radial plates of these hyphae grow downward rapidly and form ridges, which are the first signs of the lamellae. As soon as these appear, the hyphae of the gills spread laterally, leaving a groove along the edge of the lamella. In the very earliest stages of the development of the lamellae they are differentiated into a lightly staining central region, and the heavily staining lateral regions made up of the tips of the hyphae. The vertical tangential sec-

tions (Figs. 6 and 7) show this feature. The central light region is the primordium of the trama of the lamella, while the heavily staining lateral regions are sections of the hymenium of the lamella. The broadening of the lamellae is brought about by the downward intercalary growth of fine, sharp-pointed hyphae in the trama. When their tips reach the groove at the edge of the lamella, they turn horizontally to form the hymenium. The hyphae of the hymenium are not large enough at this stage to stand out distinctly, but soon distinct, scattered, swollen hyphae stand out above the hymenium surface. These are cystidia. They are clavate, measure 20–22 μ long and 8–10 μ broad, and have large, deeply staining nuclei 4–6 μ in diameter.

As the lamellae grow in width, the trama becomes thicker because of the intercalary growth of new hyphae. But in a later stage, as shown by the sections of older lamellae (Fig. 8), the hyphae of the trama have increased in diameter causing the thickening of the trama in the upper part of the lamellae. At this stage, as Allen (1) also observed in *Hypholoma,* the cystidia appear greatly separated, indicating that some intercalary growth has taken place in the hymenium. A few observations have led to the belief that this hymenial growth is due to the branching of hyphae at the clamp connections in the subhymenium. The basidia are of the typical form and have four spores.

At an early stage, when the carpophores are about 4 mm. in diameter, the portion of the universal veil directly above the pileus dissolves into a viscid layer, and the cortical layer of the pileus secretes enough viscid substances to keep it coated through the rest of its development. In older specimens this viscid layer is about 0.1 mm. thick (Fig. 8). However, very small, pure-white patches of the universal veil may persist along the outer margin of the pileus until late stages. Figures 9 and 10 show this character and also the thick partial veil completely concealing the lamellae. In a still later stage this partial veil ruptures about midway between the stem and the margin of the pileus. It is thus left partially appendiculate to the margin of the pileus and partially as a distinct, white annulus which is striately lamellate on its upper surface (Figs. 10–12). In some specimens the

annulus is early evanescent, but in most it persists to old age. It is difficult to keep dried specimens with the annulus intact.

This species was reported as new by Peck (6) in 1898. The specimens from which the determination was made were sent by Dr. Lane from Portland, Oregon. Peck says, "The dried specimens have the general appearance of some species of *Stropharia,* but the appendiculate character of the veil and the *entire absence* of an annulus indicate that the species is a *Hypholoma.*" Then, in 1912, Murrill (5), in summing up the species of *Hypholoma* of the Pacific Coast, says of this one: "The species belongs naturally in *Stropharia,* but the large veil is *entirely* appendiculate and leaves *no* annulus." Figure 12 is a photograph of a specimen of my collection, No. 91, referred to by Murrill (5). The dried specimens of this collection which were sent to him for determination probably have no annulus intact.

In the light of the present investigation there are two lines of differentiation between this species and *Hypholoma.*

First, in the early states of *Hypholoma,* as worked out morphologically by Allen (1) and later verified by Beer (3), the differentiation of the parts does not correspond to that of this species. In *Hypholoma* the differentiation of the pileus preceded the other parts. Beer (3) also says that in *Clitocybe laccata* "the first differentiation of the carpophore primordium consists in the demarcation of the pileus." In *Stropharia ambigua* the first differentiation is the appearance of the primordium of the hymenium. Atkinson (2) found this true in *Agaricus campestris,* and Beer (3) observed the same order of development in *Armillaria mellea.* Thus, according to our present knowledge of the development of the carpophores of the Agaricaceae, with one exception the annulate forms develop the hymenial primordium first, while other forms develop the primordium of the pileus first. Fischer's work (4) on an annulate form may show an exception; but it seems to the writer that according to Fischer's findings the differentiation of the hymenium brings about the differentiation of the pileus, and Beer (3) suggests that the differentiation of the pileus and hymenium in this case is possibly simultaneous. Further investigation on these two types has been started by the writer.

Second, there is an annulus present in this species. This feature has been noticed with interest since specimen No. 91 was determined (5). Students in a course in Fungi at the University of Washington have invariably traced it to the genus *Stropharia*. It is true that a part of the veil is characteristically appendiculate but the greater part forms a pendulous annulus, which is thick, membranaceous, and pure-white, but for the purplish-brown edges of the striate lamellae on the upper surface. The annulus is cone-shaped, has a fimbriate margin, and is fixed.

Since it is evident from these two standpoints that this plant has been taxonomically misplaced, the new combination **Stropharia ambigua** (*Peck*) is proposed.

The lamellated upper surface of the annulus brings *S. ambigua* into close relationship with the little *S. bilamellata* Peck (7). However, *S. ambigua* is much larger and leaves a portion of the veil appendiculate.

The writer is under obligations to Dr. J. W. Hotson for helpful suggestions in this work.

SUMMARY

1. The species in question does not develop like *Hypholoma*, but like the annulate forms.

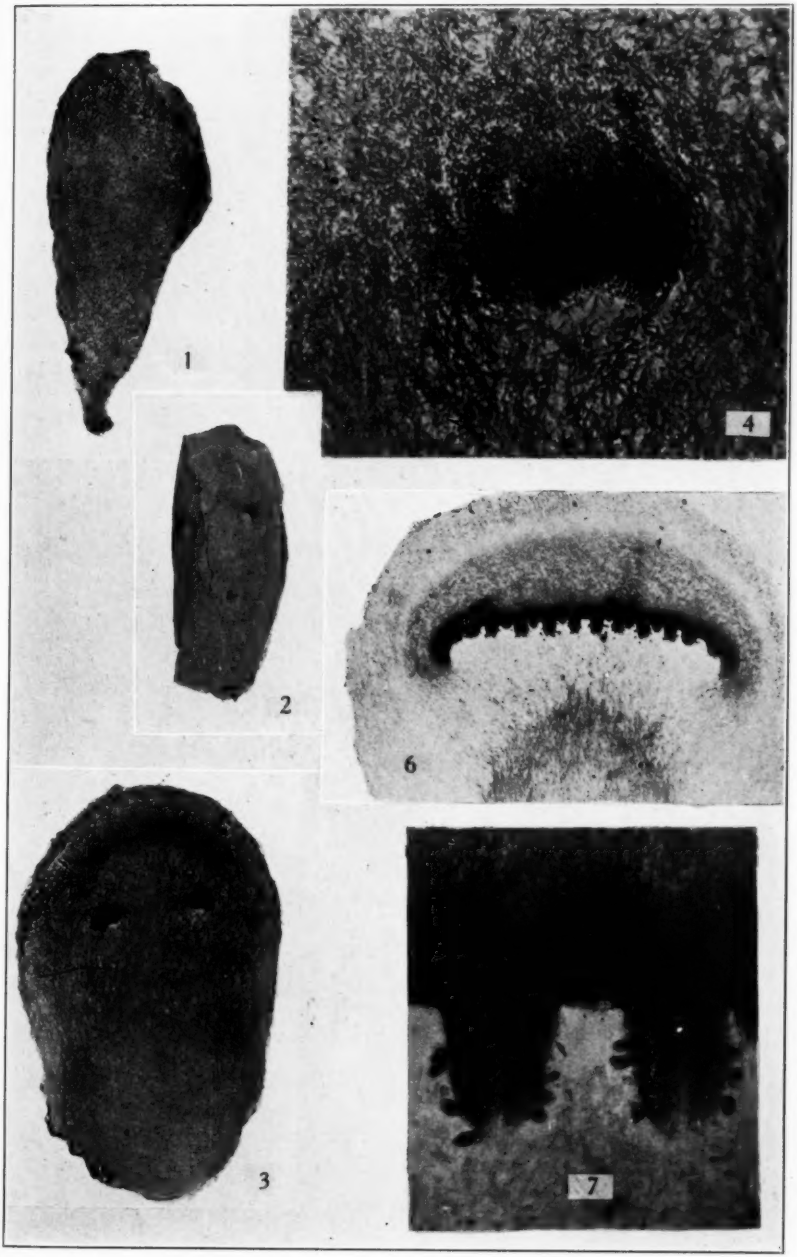
2. In its young stages it has an annulus which is sometimes evanescent.

3. Therefore the new combination, **Stropharia ambigua** (Peck), is proposed.

UNIVERSITY OF WASHINGTON,
SEATTLE, WASHINGTON.

LITERATURE CITED

1. **Allen, Caroline L.** The Development of Some Species of *Hypholoma*. Ann. Myc. **4**: 387–394. 1906.
2. **Atkinson, Geo. F.** The Development of *Agaricus campestris*. Bot. Gaz. **42**: 241–264. 1906.
3. **Beer, Rudolf.** Notes on the Development of the Carpophore of Some Agaricaceae. Ann. Bot. **25**: 683–689. 1911.
4. **Fischer, C. C. E.** On the Development of the Fructification of *Armillaria mucida* (Schrad.). Ann. Bot. **23**: 503–507. 1909.
5. **Murill, W. A.** Agaricaceae of the Pacific Coast. Mycologia **4**: 304–305. 1912.



STROPHARIA AMBIGUA (PECK) ZELLER

STROPHARIA AMBIGUA (PECK) ZELLER

6. **Peck, Chas. H.** New Species of Fungi. Bull. Torrey Club **25**: 325–326. 1898.

7. **Peck, Chas. H.** New Species of Fungi. Bull. Torrey Club **22**: 204. 1895.

DESCRIPTION OF PLATES CXXIV AND CXXV

Photomicrographs by Homer O. Blair and photographs by the author.

Fig. 1. Young carpophore undifferentiated; × 30.

Fig. 2. Young carpophore with hymenial primordium developed, but no evidence of the primordium of the pileus; × 30.

Fig. 3. Young carpophore showing the hymenial primordium farther developed than in Fig. 2 and the appearance of the primordium of the pileus; × 30.

Fig. 4. From same young carpophore as Fig. 3; the primordium of the hymenium showing the beginning of the gill cavity; × 300.

Fig. 5. Part of young carpophore showing the gill cavity; the primordium of the hymenium continues to develop as the margin of the pileus continues to grow; young lamellae in longitudinal section; partial veil of loose filaments; and cortex of the stem; × 30.

Fig. 6. Tangential section of young carpophore showing young lamellae in cross section; the lightly staining central portion is the trama; cystidia; × 30.

Fig. 7. Greater magnification of the same lamellae as shown in Fig. 6, showing the trama, hymenium and cystidia with large spherical nuclei; × 300.

Fig. 8. Tangential section of more mature pileus and lamellae; the trama of the pileus; superficial viscid layer; trama, subhymenium and hymenium of the lamellae; × 60.

Fig. 9. Pileus of carpophore showing small flocculent patches of the universal veil and the partial veil completely covering the lamellae. Nat. size.

Fig. 10. Carpophore showing partial veil ruptured leaving annulus and partly appendiculate. Nat. size.

Fig. 11. Same object as Fig. 10 with part of pileus cut away to show annulus. Nat. size.

Fig. 12. Dried specimen (Zeller, No. 91) showing annulus. Nat. size.

MOUNTAIN MYXOMYCETES

T. H. Macbride

Slime moulds are such ubiquitous things that we might imagine all species universally distributed and the forms of one locality precisely those of every other, once the lists are with accuracy compared. This might well be the case indeed since these forms are manifestly sown by wind currents, their spores swept by every aerial movement, probably round and round the world.

Furthermore, slime moulds, in the nature of the case, are essentially woodland things; they affect the shade, love rotting logs and piles of fallen leaves, and one might expect to find them alike in all the forests of the continent. But such is by no means the situation. These curious heirs of primitive life differ in different forests, and vary from mountain range to mountain range, and up and down the meridians of the world, quite as do the higher plants. They respond readily to environmental change and become fixed at length in haunt and habitat.

The variation is accordingly more marked where isolation and climatic differentiation are more complete. Thus there is more concord if we compare the forests of Maine and Washington than when we attempt to study together the Rocky Mountains and the Cascades. Maine and Washington are near the ocean; the Rocky Mountains are far interior; the mountains about Puget Sound are visited by abundant rains, the Rocky Mountains are semi-arid; stretch across the "great American desert."

This opens a wide subject. It is not expected here to do more than call attention to the problem. This we may effect by presenting briefly the slime-mould species of the two regions latest named, comparing particularly Colorado and the shores of Puget Sound. Most of the work in Colorado has been done by Professor E. Bethel and Professor W. C. Sturgis; I myself have been busy on the Pacific coast. For some reason, not clear to me at present, the Colorado field is remarkable for its wealth of calcareous types: at least in the light of present knowledge, the

physarums and their kin abound in the Rocky Mountains about Denver and are scarce in the far West. Conversely about Puget Sound the trichia and lamproderma types are practically universal and dominant.

A few notes of species, cited in detail, may make this situation clear.

The one calcareous slime-mould everywhere in the west from the islands of San Juan to the glaciers of Mt. Rainier is the familiar *Fuligo, F. septica* L., we must finally say. So far as my observation goes, in the Washington forest every day from July to January, but one phase of the species is to be found, viz.: *F. ovata* Schaeffer. Generally specimens are rather small, but on the foot hills of the great mountain they are not only abundant but extremely large. On decaying stumps in a hemlock forest the yellow plasmodia seemed to affect the landscape, so many of them all around, so large, that the foamy plasma might have been dipped up with a cup!

In contrast with this we have in Colorado three described species, and no knowing how many phases of these species, in the protean genus. The species are distinguished chiefly by spore-characters. Thus, *F. septica* L. has spores almost smooth, pale violaceous 6–7 μ; *F. ellipsospora* R. has spores ellipsoidal, dark-colored, rough, 10–12 μ; *F. megaspora* Sturg., spores globose, very dark and rough, 18–20 μ. There is still another form repeatedly taken in Colorado with globose spores dark-colored and rough, about 10–12 μ in size. This is dull gray and fits in between the first and third named, and might be called *F. media.*

We have in the west beautiful colonies of *Lepidoderma,* probably *L. tigrinum* (Schrad.) R.; in the Rocky Mountain district this is reported "found but once in Colorado." This is a calcareous type, it is true, but looks rather in the direction of *Stemonitis.*

But it is in the great genus *Physarum* itself that the contrast becomes more apparent. Here the Colorado lists include some twenty-two species to which the Iowa herbarium may add one or two. Here is one that we may call *Physarum elegans,* very much like *P. pusillum* (Berk.) Lister, but with larger, orange or brown, short-stalked, sporangia. Here is another that has porcelain-like

walls, uniform capillitum with the usual violaceous rough spores, but unlike anything in the *P. nephroideum* group. Other calcareous genera are equally represented: there are about eight didymiums, four or five didermas, etc.

Mucilago spongiosa (Leys) Morg. in the forests about Mt. Rainier is not at all uncommon. Its flecks of spume sometimes deck the stems and twigs of living plants all along a watercourse. The light calcareous foam blows away as soon as dry, and leaves a curious dendritic, strangely intricate, grayish fructification quite confirming Rostafinski's figure 175. In Colorado, on the other hand, the same species retains its limey covering, shows almost no internal structure, and is almost as firm as the substratum, justifying Professor Sturgis when he writes var. *solida.*

To nearly all the Colorado forms so far discussed, one remark applies: they are peculiar. Even where representing species widely known and studied, the Rocky Mountain gatherings would nearly all be subject of remark no sooner seen. Furthermore the peculiarity is, I believe, in many cases referable to the abrupt alternation in Colorado climate. Plasmodia called into being by the melting snows of early summer are often checked in complete development by the dry atmosphere suddenly encountered as they rise to fruit, and abnormality is the result. The most normal presentations I have from Colorado are of those species which habitually fruit in less exposed positions, as on the lower side of stems, logs or heaps of mouldering vegetation. Such species are *Badhamia utricularis* (Bull.) R.; *Comatricha nigra* (Pers.) Schr.

The *Fuligo* species cited are worthy of further notice. It is of course observed that the spores in the three more closely related forms are singularly graded in size; thus—*F. septica,* 6–7 μ; *F. media,* 10–12 μ; and *F. megaspora,* 18–20 μ.

Knowing what we do, by the researches of Harper, concerning the cytology of *Fuligo,* this correlation in size is very suggestive. Professor Harper has shown that the uninuclear spore is the issue of a peculiar plasmodical cleavage, whose progress in a given case may be arrested almost anywhere; so that we might have reproductive bodies by this process ranging from large sclerotia to the smallest spores.

Turning now to the Puget Sound collections, it is to be noted that we have from both Oregon and Washington less than a dozen physarums, three didymiums so far and only three or four didermas, and these not abundant. On the other hand cribrarias are on every log, and although the number of species of *Trichia* or *Hemitrichia* is not large, the number and extent of their colonies is surprising. *T. decipiens* and *T. botrytis* are the common types, but neither is like forms of the same species as presented in the central parts of the continent. They are in every case larger; they open in sharply circumscissile fashion, standing in colonies often several feet in extent. *T. botrytis,* if such it be, is not quite Persoon's species, it is not botryoid at all. I have never seen so many as two sporangia adhering. Later on, the large empty vases of both species stand long, quite like those of *Hemitrichia clavata.*

But robust comatrichas and lamprodermas are the striking features of the myxo flora about Puget Sound. These are everywhere; lamprodermas at sea-level and comatrichas on the mountains; on Mt. Rainier up at the last limit of the firs, 8–9,000 ft., I found *C. nigra* (Pers) Schr. and especially *C. suksdorfii* Ell., beautiful and abundant sepcimens. Stemonitis species are few and rare; the colonies feeble when found, except at low levels where at least two species occur, but not *S. splendens* R.

At 7,000 ft. *Arcyria vitellina* Phill. particularly the form *A. versicolor* occurs in wide colonies of large sporangia, twice the size of those seen in Colorado. *A. versicolor,* is olivaceous yellow with touches of dull red. *A. vitellina,* pure yellow, is in Colorado and Southern California.

But the lamprodermas of the Mt. Rainier neighborhood are, as just stated, all a surprise. They all merit Ellis's name *robusta,* and their far stretching colonies all gleaming in marshalled and metallic splendor are beautiful to behold.

In fine, not to prolong this argument, so far as present knowledge goes, the slime-mould floras of the two mountain regions named are distinct as the mountains themselves. Dominants and recessives no doubt play their respective parts, but meteoric environment ultimately casts the die.

UNIVERSITY OF IOWA,
IOWA CITY, IOWA.

NEWS, NOTES AND REVIEWS

The *Journal of Agricultural Research* for January contains an account by Della E. Ingram of a disease caused by a fungus which is referred to *Diplodia longispora* Cooke & Ellis. While the disease usually attacks the chestnut oak, it may also attack the chestnut and other species of oaks. The trees are not killed outright but may die as a result of weakening from the attacks of the disease. The disease gains access to the plant through wounds in the bark.

Contribution No. 144 from the Botanical Department of the University of Michigan is a record of researches on the mycorrhizas of forest trees by W. B. McDougal. As a result of this work, four species of fungi are added to the known list of ectotropic mycorrhiza-forming fungi, as follows: *Russula* sp. on *Tilia americana, Boletus scaber fuscus* on *Betula alba papyrifera, Cortinarius* sp. on *Betula alba papyrifera,* and *Scleroderma vulgare* on *Quercus alba.* It is stated that at least four different species of mushrooms may form mycorrhizas on the same tree.

It has recently been shown by F. C. Stewart and W. H. Rankin, of Geneva, New York, that it is probable that *Cronartium ribicola* rarely, if ever, winters over on the currant as it has been suspected of doing from the severe outbreak of the currant rust in that vicinity. This rust in its aecial stage is known as *Peridermium Strobi* and affects those species of *Pinus* which have their leaves borne in clusters of five. The rust is perennial on the pine but cannot spread directly from one pine to another. The recent outbreak of currant rust was found to be due to two pine trees infected with the blister-rust.

The New York Botanical Garden recently acquired the Mycological herbarium of William R. Gerard, who died suddenly in New York City, February 26, 1914. He was born in Newburgh, N. Y., March 26, 1841, and in boyhood entered the employment of a druggist in Poughkeepsie; remaining in the same business until finally he became proprietor of a drug store in that city.

He began the study of fungi at a time when few American botanists had devoted attention to this group of plants, his first descriptions of new species appearing in the *Bulletin of the Torrey Botanical Club* for October, 1873, before the publication of the earliest mycological papers of Burrill, Ellis, Farlow, or Morgan. In the following year, he was one of the founders of the Poughkeepsie Society of Natural Science, in whose *Proceedings* a number of his botanical papers were published. In 1877, he removed to New York City, where he was an active member of the Torrey Botanical Club for some years. Before the death of William H. Leggett, the founder and editor of the *Bulletin,* Mr. Gerard was made assistant editor, and he followed him as editor, filling that office from April, 1882, to December, 1885. In later years he was interested in the derivation of plant names, especially those of American Indian origin, and contributed papers on this subject to *Garden and Forest* in 1895 and 1896. Otherwise, his botanical studies seem to have ended with the year 1885.

AGARICUS XYLOGENUS Mont.

Agaricus (*Psalliota*) *xylogenus* Mont. Syll. Crypt. 122. 1856 was described as follows from plants said to have been collected by Sullivant on dead wood near Columbus, Ohio, in August: "Pileus conic to campanulate, umbonate, 3–6 cm. broad; surface smooth, luteous, fuscous at length on the umbo, margin striate when dry; stipe white, 7 cm. long, 5 mm. thick, slightly larger at the base, hollow, with a persistent annulus below the middle; lamellae free, remote, rose-colored as in *A. campestris;* spores globose, 5–7.5 μ, discolored-hyaline; related to *Agaricus cepaestipes.*"

Sullivant had two collections numbered 140. The plants described, which do not grow on wood, resemble a *Lepiota,* with long, slender stipe, brown umbo, and a good superior annulus, but no scales such as occur in *L. procera.* They are neither *L. cepaestipes* nor *L. Morgani.* The other No. 140, called 140[2] by Montagne, is totally different from the one described and is attached to dead wood, thereby deserving the specific name. The pileus is white, glabrous, apparently viscid, distinctly umbonate,

3 cm. broad in the dried state; lamellae white, crowded; stipe slender, glabrous, slightly enlarged below; annulus inferior.

W. A. MURRILL.

A NEW BOOK ON THE BRITISH RUST FUNGI*

In 1889, Plowright brought out the first monographic account of the rusts of England. In the twenty-four years which intervened before the next comprehensive treatment of the group by Grove, in 1913, it is not surprising to find that sufficient information has accumulated to make the latter presentation much more bulky than the former. Plowright treated both the rusts and smuts in a single volume of 347 pages, while Grove requires in the present volume 412 pages for the rusts alone. The two authors have treated their subject in a very similar manner, giving first the biology, or natural history, of the group and following it with a systematic part which includes descriptions, hosts, and distributions. Plowright devotes 57 pages to the natural history of the rusts and 135 to their classification, whereas the later author uses 84 and 300 pages, respectively, for the two parts.

The expansion of the biological part by Grove is due partly to the fact that some entirely new topics, notably sexuality and separation of species into races, have been developed in the interim and partly to the fact that he treats at greater length the life histories of certain typical forms. It is interesting to note that *Puccinia Caricis* instead of *P. graminis* has been selected for extended consideration as "the typical Uredine." The author explains that he has done this because the aecia of *P. graminis* are rare and difficult to obtain for demonstration, while that of *P. Caricis* is common. In the second, or systematic portion, the increase in the recent book is due chiefly to the larger number of species included, although the more complete descriptions with somewhat fuller notes would call for more space. A comparison of the two main genera, *Puccinia* and *Uromyces,* will throw some light on the taxonomic situation from the standpoint of the species. Plowright included 100 species of *Puccinia* and 38 of *Uromyces,* while Grove has added 37 species of *Puccinia* and 10

* The British Rust Fungi. By W. B. Grove, M.A., Pp. xii, 412. 290 text figs. Cambridge: at the University Press. 1913.

of *Uromyces*. As to genera, the situation is perhaps still more striking, Plowright having included all species under 11 genera as compared with a list of 24 by Grove. It must be noted, however, that some genera have been discussed which have not yet been collected in England, but which the author apparently believes may be found there at any time on account of their prevalence in Europe.

The book is well printed, profusely illustrated, and makes a neat appearance. The illustrations are original and highly satisfactory. They are very similar to those in Fischer's Uredineen der Schweiz, from which work the general form of the drawings seems to have been adapted.

The author very generously acknowledges that the descriptions of species are based upon Sydow's Monographia Uredinearum. In some instances it is regrettable that this work has been followed so closely as to include some of its errors. The descriptions are said to be revised and amended but evidence of culture work or first hand investigations of many of the special problems is usually lacking. Other writers' opinions are rather freely cited, but there is frequently considerable hesitation about the adoption of results if they differ from the usual disposition. In the citation of names, the dates have been intentionally omitted. As they are frequently important and would have required no additional space and little extra time in preparation, there seems to be no sufficient reason for such a procedure.

Sometimes statements in the biological discussions are of such a nature, either because of incompleteness or dogmatic form, as to attract attention. On p. 33, in a discussion of germ-pores in urediniospores, the statement is made that only one species of *Puccinia*, *P. monopora*, is known with the urediniospore possessing a single pore, although *P. uniporula* was published in 1912 (Orton in MYCOLOGIA **4**: 201). Since that time the reviewer has found *Puccinia Veratri* and an undescribed *Uredo* on *Geranium mexicanum* to have 1-pored urediniospores, which suggests that the character is probably not so rare as was believed formerly. The conception of amphispores as given on p. 34 is not very clear, as is evidenced by the fact that Fig. 22 is given as an amphispore of *Puccinia Pruni-spinosae*, and that in the technical de-

scription on p. 208 amphispores are not mentioned in this species, while Fig. 156*b* is an exact duplication of Fig. 22, and is labeled "uredospore." Those who are interested in the evolution of the group will note that the author has very decided opinions in the matter when he states without qualifications that *Endophyllum*, whose aeciospores germinate as soon as mature with a basidium, represents "the primitive state of things from which the present wide division of labor into rejuvenating (aecidio-), multiplying (uredo-), and resting (teleuto-) spores has been evolved." Of wide interest also is the observation that "immunity depends chiefly (perhaps entirely) upon the ability of the cytoplasm to resist infections by secreting antitoxins which will kill the mycelium of the fungus."

FRANK D. KERN.

INDEX TO AMERICAN MYCOLOGICAL LITERATURE

Allard, H. A. The mosaic disease of tobacco. U. S. Dept. Agr. Bull. 40: 1–33. *pl. 1–7.* 15 Ja 1914.

Allen, R. F., & Jolivette, H. D. M. A study of the light reactions of *Pilobolus.* Trans. Wisconsin Acad. Sci. **27**: 533–598. *f. 1–21.* D 1913.

Atkinson, G. F. The development of *Agaricus arvensis* and *A. comtulus.* Am. Jour. Bot. **1**: 3–22. *pl. 1, 2.* F 1914.

Beardslee, H. C. Notes on a few Asheville fungi. Mycologia **6**: 88–92. *pl. 121.* 18 Mr 1914.
Includes *Russula rubescens* sp. nov.

Brown, N. A., & Jamieson, C. O. A bacterium causing a disease of sugar-beet and nasturtium leaves. Jour. Agr. Research **1**: 189–210. 10 D 1913.
Bacterium aptatum sp. nov.

Burrill, T. J. *Bacillus amylovorus* vs. *amylivorus.* Phytopathology **4**: 31. F 1914.

Cook, A. J. Alfalfa. Monthly Bull. State Comm. Hort. Calif. **3**: 53–73. *f. 8–17.* F 1914.
Includes a list of fungous diseases.

Dietel, P. Über einige neue und bemerkenswerte Uredineen. Ann. Myc. **12**: 83–88. 10 F 1914.
Includes four new species from America.

Dox, A. W. A review of recent investigations on the mineral nutrition of fungi. Biochem. Bull. **3**: 222–228. Ja 1914.

Farley, A. J. Peach leaf-curl. New Jersey Agr. Exp. Sta. Circ. 29: 1, 2. *f. 1, 2.* 1914.

Fink, B. Henry Willey,—a memoir. Mycologia **6**: 49–53. 18 Mr 1914. Portrait.

Fraser, W. P. Notes on *Uredinopsis mirabilis* and other rusts. Mycologia **6**: 25–28. 14 Ja 1914.

Galloway, B. T. Pierre-Marie-Alexis Millardet. Phytopathology **4**: 1–4. *pl. 1.* F 1914.

Gloyer, W. O. The efficiency of formaldehyde in the treatment of seed potatoes for Rhizoctonia. New York Agr. Exp. Sta. Bull 370: 417–431. *pl. 1.* D 1913

Graves, A. H. *Fomes laricis* in California. Phytopathology **4**: 33. F 1914.

Graves, A. H. Notes on diseases of trees in the southern Appalachians II. Phytopathology **4**: 5–10. *pl. 2* + *f. 1.* F 1914.

Graves, A. H. A preliminary note on a new bark disease of the white pine. Mycologia **6**: 84–87. *pl. 120.* 18 Mr 1914.

Güssow, H .T. The systematic position of the organism of the common potato scab. Science II. **39**: 431–433. 20 Mr 1914.

Harper, E. T. *Cantharellus clavatus* from Duluth. Mycologia **6**: 40, 41. 14 Ja 1914.

Harper, R. A., & Dodge, B. O. The formation of the capillitium in certain *Myxomycetes.* Ann. Bot. **28**: 1–18. *pl. 1, 2.* Ja 1914.

Harter, L. L. The foot-rot of the sweet potato. Jour. Agr. Research **1**: 251–274. *pl. 23–28* + *f. 1.* 10 D 1913.

Heald, F. D. Aerial galls of the mesquite. Mycologia **6**: 37, 38. *pl. 117, f. 2.* 14 Ja 1914.

Hewitt, J. L. Twig blight and blossom blight of the apple. Arkansas Agr. Exp. Sta. Bull. 113: 495–505. 1913.

Howitt, J. E. Notes on the apothecial stage of *Sclerotinia cinerea* in Ontario. Ottawa Nat. **27**: 158–160. F 1914.

Ingram, D. E. A twig blight of *Quercus prinus* and related species. Jour. Agr. Research **1**: 339–346. *pl. 38* + *f. 1–7.* 10 Ja 1914.

Johnson, D. S. The evolution of a botanical problem. Science II. **39**: 299–319. 27 F 1914.

Jolivette, H. D. M. Studies on the reactions of *Pilobolus* to light stimuli. Bot. Gaz. **57**: 89–121. *f. 1–12.* 14 F 1914.

Kern, F. D. The nature and classification of plant rusts. Trans. Am. Micros. Soc. **32**: 41–67. *f. 1–5.* 1913.

Krieger, L. C. C. Observations on the use of Ridgway's new color-book. The color of the spores of *Volvaria speciosa* Fr. Mycologia **6**: 29–31. 14 Ja 1914.

Kunkel, L. O. Nuclear behavior in the promycelia of *Caeoma nitens* Burrill and *Puccinia Peckiana* Howe. Am. Jour. Bot. **1**: 37–47. *pl. 3*. F 1914.

Lewis, D. E. The control of apple blotch. Kansas Agr. Col. Exp. Sta. Bull. 196: 521–574. *f. 1–19, 21*. D 1913.

Long, W. H. *Polyporus dryadeus,* a root parasite on the oak. Jour. Agr. Research **1**: 239–250. *pl. 21, 22*. 10 D 1913.

Long, W. H. An undescribed species of *Gymnosporangium* from Japan. Jour. Agr. Research **1**: 353–356. 10 Ja 1914.
Gymnosporangium chinensis sp. nov.

McMurran, S. M. The anthracnose of the mango in Florida. U. S. Dept. Agr. Bull. **52**: 1–15. *pl. 1–4* + *f. 1–4*. 24 Ja 1914.

Meinecke, E. P. Forest tree diseases common in California and Nevada. U. S. Dept. Agr. Forest Serv. 1–67. *pl. 1–24*. 14 F 1914.

Mercer, W. H. Investigations of timothy rust in North Dakota during 1913. Phytopathology **4**: 20–22. F 1914.

Murrill, W. A. *Agaricus mucifer* Berk. & Mont. Mycologia **6**: 97, 98. 18 Mr 1914.

Murrill, W. A. An enemy of the western red cedar. Mycologia **6**: 93, 94. *pl. 122*. 18 Mr 1914.
Includes *Fomitiporia Weirii* sp. nov.

Murrill, W. A. Illustrations of fungi—XVII. Mycologia **6**: 1–4. *pl. 113*. 14 Ja 1914.
Includes *Hydrocybe caespitosa* sp. nov.

Oosthuizen, J. D. P., & Shedd, O. M. The effect of ferments and other substances on the growth of Burley tobacco. Jour. Biol. Chem. **16**: 439–453. Ja 1914.

Orton, C. R., & Adams, J. F. Notes on *Peridermium* from Pennsylvania. Phytopathology **4**: 23–26. *pl. 3*. F 1914.

Orton, W. A. The biological basis of international phytopathology. Phytopathology **4**: 11–19. F 1914.

Orton, W. A. Potato wilt, leaf-roll, and related diseases. U. S. Dept. Agr. Bull. 64: 1–48. *pl. 1–16.* 10 F 1914.

Rand, F. V. Some diseases of pecans. Jour. Agr. Research **1**: 303–338. *pl. 33–37 + f. 1–8.* 10 Ja 1914.

Reed, G. M. An unusual outbreak of apple blossom blight. Phytopathology **4**: 27–30. F 1914.

Reed, H. S., Cooley, J. S., & Crabill, C. H. Experiments on the control of the cedar rust of apples. Virginia Agr. Exp. Sta. Bull. **203**: 3–28. *f. 1–11.* Ja 1914.

Rorer, J. B. The green muscardine fungus and its use in cane fields. Board Agr. Trinidad & Tobago Circ. **8**: 5–14. *pl. 1, 2 + f. 1, 2.* 31 Mr 1913.

Rorer, J. B. The Suriname witch-broom disease of Cacao. Board Agr. Trinidad & Tobago Circ. **10**: 5–13. 30 Jl 1913.

Seaver, F. J. A preliminary study of the genus *Lamprospora.* Mycologia **6**: 5–24. *pl. 114.* 14 Ja 1914.

Includes *Lamprospora ascoboloides, L. annulata, L. spinulosa, L. Maireana, L. tuberculatella,* spp. nov.

Seaver, F. J., & Murrill, W. A. Notes on truffles recently collected in the eastern United States. Jour. N. Y. Bot. Gard. **15**: 14, 15. Ja 1914.

Smith, E. F. Identity of the American and French mulberry blight. Phytopathology **4**: 34. F 1914.

Stewart, V. B. Specific name of the fire blight organism. Phytopathology **4**: 32, 33. F 1914.

Stewart, V. B. The yellow-leaf disease of cherry and plum in nursery stock. Cornell Univ. Agr. Exp. Sta. Circ. 21: 1–10. *f. 1–9.* Ja 1914.

Sumstine, D. R. New or interesting fungi. Mycologia **6**: 32–36. *pl. 115–117.* 14 Ja 1914.

Includes *Hormisciopsis* gen. nov. and *H. gelatinosa, Arthrosporium album, Streptothrix pereffusa, Oidium album, Polyscytalum flavum, Vaginata umbonata,* and *Marasmius Morganianus,* spp. nov.

Taubenhaus, J. J. The why's in plant disease control. Gard. Chron. Am. **17**: 819–821. F 1914.

Theissen, F. Über *Polystomella, Microcyclus* u. a. Ann Myc. **12**: 63–75. *pl. 6, 7.* 10 F 1914.

Includes *Polyclypeolum, Microcyclella, Clyclotheca, Cryptopus,* and *Ellisiodothis,* gen. nov.

Vosler, E. J. Calendar of insect pests and plant diseases. State Comm. Hort. Monthly Bull. Calif. **3**: 44–46. *f. 7.* Ja 1914.

Wallace, E. Scab disease of apples. Cornell Agr. Exp. Sta. Bull. **335**: 545–624. *pl. 1–11* + *f. 184.* S 1913.

Wilson, G. W. Studies in North American *Peronosporales*—V. A review of the genus *Phytophthora.* Mycologia **6**: 54–83. *pl. 119.* 18 Mr 1914.

Winslow, C. E. A. The characterization and classification of bacterial types. Science II. **39**: 77–90. 16 Ja 1914.